

Technology Review

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THE AIRCRAFT INDUSTRY GOES GLOBAL

★
IS THE U.S. READY?



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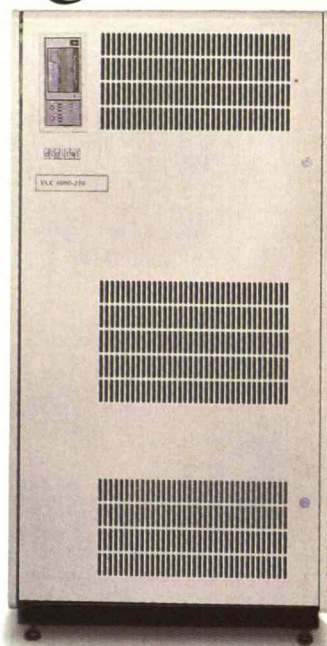


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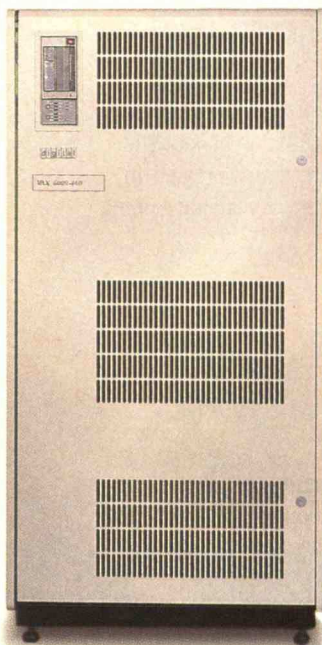
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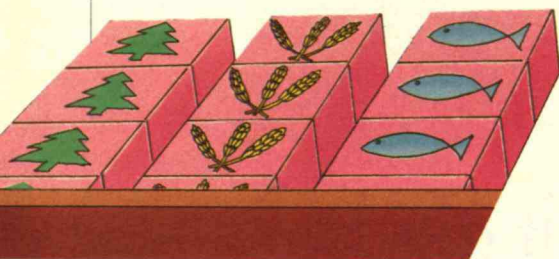


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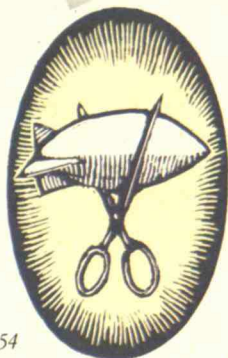


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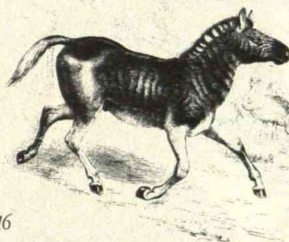
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Continuity and Change

I wouldn't mind if a few readers didn't even notice our new design. We have made changes not for their own sake but when we saw good reason for them. In several cases we examined dozens of possibilities only to end up not far from where we started.

The *Technology Review* logo is a case in point. A redesign in 1967 changed the typeface of the entire magazine, including the logo, to Helvetica. Though this clean, sans-serif face later became widely popular, *Technology Review's* early adoption of it was bold and controversial. Today, fashion is returning to classical typefaces. We reviewed earlier logos stretching back to 1899 with an eye to resurrecting one, but thought better of the idea.

True, there is merit in today's classical revival. Helvetica is difficult to read. Ironically, when type is stripped of all adornment, the eye has trouble taking in entire words at a glance. I suspect this does not result entirely from a centuries-long habituation to serif type but illustrates a psychological principle. People prefer the tiny foot or flag, the serif, that punctuates the top and bottom of letters: we want beginnings and endings to be articulated.

Nevertheless, a large Helvetica logo is perfectly readable and has an advantage for *Technology Review*. Designed in the Bauhaus tradition, the type embodies an optimism about technology and modernism that is lacking in today's resurrections of classical styles. Though well aware of technological setbacks, we wish to maintain the guidance of this optimism. We have kept the Helvetica logo, but the interior of the magazine is now entirely in serif type.

In the decade since the design last received careful scrutiny, the magazine had grown piecemeal and needed to be brought to order. The Trends section was announced in Lubalin type, dropped out white on a black background, while other section heads were Baskerville, and running heads remained Helvetica. Now all section heads and titles are in a single, handsome typeface, Garamond.

There were geographical problems, too. Reporter, covering developments at MIT, once occupied only the last page of the magazine but had begun taking up two or three pages. The editors slipped through a solution that horrified the upper echelons of the design department: we started the section on the prominent last page and asked readers to flip backwards. We have now moved Reporter to the front of the

Covers from 1916 to the present

magazine, an arrangement that allows for several pages and emphasizes the section's importance.

Our design director, Nancy Cahners, oversaw the entire revamping process. Our design manager, Kathleen Sayre, took the critical step of translating a set of verbal requirements into handsome physical form. Our publisher, William Hecht; our managing editor, Sandra Hackman; and the rest of the staff, including myself, kibitzed.

An ad-hoc design committee advised us throughout. Robert Mann, the chair, and Woodie Flowers, both professors of mechanical engineering at MIT, brought from their experience intuitions about design that I found sometimes startling and almost always unerring. Edward Thompson, chair of our Advisory Board and former editor of *Reader's Digest*, kept us from running off the rails at perilous junctions. Other committee members we are indebted to include Emily Wick, former dean of students at Mount Holyoke; Warren Seamans, director of the MIT Museum; and (particularly for insights about the logo) Jacqueline Casey, former director of Design Services at MIT. ■

JONATHAN SCHLEFER

Letters

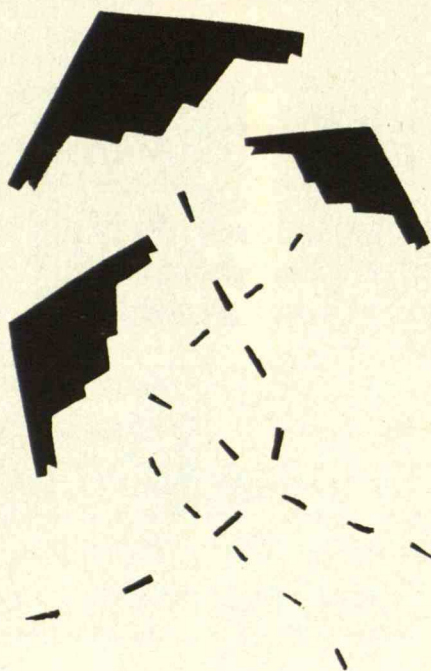
THE CASE FOR STEALTH

After reading "In Search of the Elusive Stealth Bomber" by Michael Brower (*TR May/June 1989*), I am compelled to add some balance to the author's one-sided view. First of all, Mr. Brower asserts that the strategic penetrating bomber is obsolete, but in fact it will play an even larger role in the future. Thoughtful people, including those who formulate the arms-reduction positions of the United States and the Soviet Union, agree that greater reliance on penetrating bombers is necessary for stable deterrence. One of the rules established in the talks at Reykjavik explicitly recognizes this by counting each penetrating bomber as one warhead regardless of the bomb load. Moreover, such craft allow for unparalleled capability and versatility in strategic nuclear deterrence, conventional operations, and support of maritime operations.

None of this argues against air-launched cruise missiles (ALCMs); Mr. Brower's statement that ALCMs are "relegated to a secondary and wasteful role of paving the way for penetrating bombers" is nonsense. The plan is to use cruise missiles against the targets they cover best—as is the case with every element of the triad of strategic deterrent forces.

Mr. Brower's argument that the B-2 mission has little to do with preventing war and much to do with fighting one is apparently based on a misunderstanding of the fundamentals of deterrence. The B-2 deters by convincing the Soviets that if they attack they will lose highly valued assets. And it makes little difference whether the retaliatory devastation would take place in an hour or a day or a week, since it is the inevitability of the destruction that deters. The B-2 provides impressive retaliatory capability without the threatening characteristics that could lead to rapid, unthinking escalation.

As to the impact of the B-2 on Soviet air-defense plans, the United States is not building the system to encourage expansion of the already massive Soviet spending in that area. Granted, the B-2 negates a huge Soviet investment over



the past two decades in conventional air defenses, but the suggestion that the plane might be vulnerable to unconventional defenses, requiring even greater expense and sophistication, is merely conjecture.

Mr. Brower also exaggerates the problems associated with "concurrency"—the policy under which the B-2 has gone into production before testing is complete. He even expresses some concern that the absence of a tail might make the craft "hard to fly." Yet the truth is that over 24,000 hours of wind-tunnel testing have been done, as well as extensive flight testing of the flight-control software. Thousands of hours of ground simulation have been performed, too. Our very high confidence that the system would do exactly what it was designed to do was verified on first flight. Not only that, but each aircraft is being built efficiently, using the same well-thought-out production setup, thanks to extensive development efforts early on.

Finally, it is not valid to compare the B-2's production scenario with that of the B-1. The B-1 was built under pressure to meet dates agreed to at the outset by the Defense Department and later mandated by Congress. In contrast, the B-2's pace depends on when development and performance milestones are

reached, and the program's schedule and costs have been adjusted to ensure that concurrency and risk are well under control.

It is important that we safeguard the revolutionary technology embodied in the B-2, which is why access to the program has been limited. Even so, as Sen. John Warner (R-Va.) of the Senate Armed Services Committee recently pointed out, members of Congress with oversight responsibility have been fully informed of the B-2's costs for the past ten years and have approved each step of the program since its inception. For the past two years, any member approved by the chair of an oversight committee has been cleared into the B-2 program. All pertinent cost information and most relevant production and schedule details are now part of the public record.

Fourth-generation stealth technology is not inexpensive, but the author's contention that the B-2 costs almost twice as much as the B-1 is simply not true. The B-2 figures he uses reflect the higher cost of producing an aircraft a full decade after the B-1's peak production years. They include the substantial R&D costs of the revolutionary technologies embedded in the B-2. In the most valid cost comparison, the B-2 costs only about 20 percent more than the B-1. Moreover, because all future fixed-wing combat aircraft will use stealth technology, the R&D effort on the B-2 will yield a stream of benefits for decades to come.

Mr. Brower's closing observation is completely correct. If the B-2 program is stretched out or the number of aircraft reduced, costs will increase and U.S. security will decrease. We need the full complement of 132 B-2s produced on schedule, and we are working closely with Congress to achieve that goal, gathering strong support from many members who understand the strategic needs of this nation. Contrary to Mr. Brower's characterization, Sen. Sam Nunn (D-Ga.) is one of those well-informed supporters. With most of the development effort on stealth behind us, we are now focusing intensely on an ef-

CORRECTION

In "Doing Something About High-Level Nuclear Waste" by George Wicks and Dennis Bickford (*TR November/December 1989*), the radiation exposure figures on page 58 are incorrectly presented as the doses that would be absorbed by workers in glassifying, transporting, and burying waste. The authors intended the figures to represent the maximum individual doses that the public would receive in the vicinity of these operations. The authors stress that workers' exposure would be higher, but well within regulatory limits.

fective flight test and economic production program to ensure that high-confidence nuclear deterrence continues.

LARRY D. WELCH
Washington, D.C.

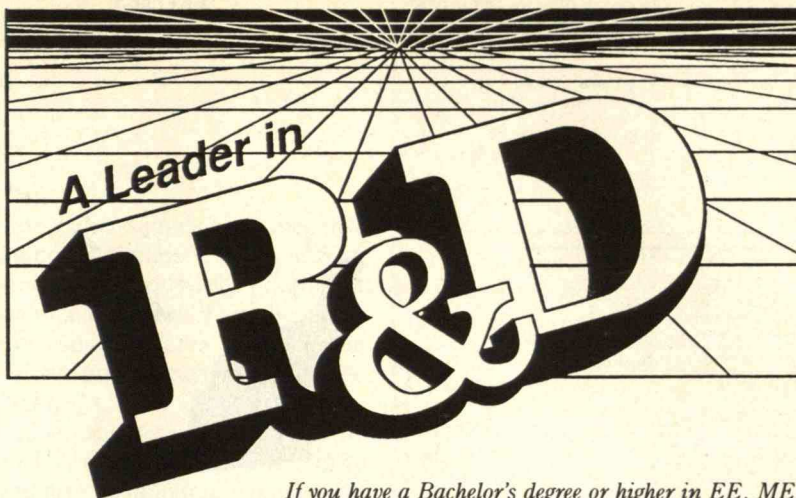
Larry D. Welch is chief of staff of the Air Force.

B-2 BLOOPERS

While I certainly enjoy your magazine, I find that I differ with some of the statements Jay H. Goldberg makes in "The Road to Stealth" (*TR May/June 1989*). He says that in the 1960s, after the Soviets shot down the U-2 flown by Francis Gary Powers, "manned overflights were banned." I believe that *all* overflights, except for satellites, were banned. Also, Goldberg refers to the SR-71 Blackbird as "an unmanned reconnaissance plane." It is my understanding that the SR-71 is in fact manned.

Finally, the author reports that in the 1973 Yom Kippur War, Israel suffered heavy losses when confronted with "new surface-to-air missiles" resistant to jamming. The truth is that the Arabs had very old continuous-wave-radar surface-to-air missiles, and the jamming equipment aboard the Israeli aircraft was designed to deal only with new pulse-Doppler radar.

GLEN CLOSSON
San Jose, Calif.



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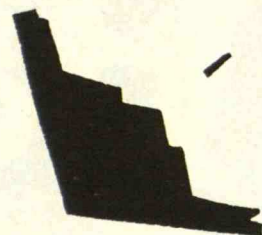
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The author responds:

In the Yom Kippur War, Israel's air force was perfectly able to handle the older SAM-2s and SAM-3s, with which it had gained experience in the War of Attrition against Egypt. However, by 1973 the Soviets had installed the newer SAM-6 in Egypt. This missile, which had radar and guidance systems that were much different from those on the earlier SAMs, foiled the Israeli jammers. The United States was able to provide Israel with electronic countermeasures to the SAM-6 by war's end, but not before the Israelis had lost a number of aircraft.

It was specifically manned overflights that were halted after the Powers incident—presumably so as not to interfere with the nascent spy-satellite programs of both superpowers. I should have said that an unmanned drone called the D-21 (which looked rather like the SR-71 and was equally stealthy) was fired from the SR-71 to fly over the Soviet Union and take photos. It is likely that the SR-71 itself eventually performed the overflights.

The SR-71 is, of course, manned. Evidently, I either pruned too much of a sentence or mistook the pilot—clearly visible in the adjacent photo—for the dummy some of us urban folk use to ride in the car-pool lanes.

NEW USES FOR HDTV

In "Who Needs HDTV?" (*TR May/June 1989*) Langdon Winner ignores a very real—and widespread—occupational health need that high-definition television might address. Specifically, many employees who work at computer terminals experience eye strain, sometimes suffering permanent damage. Since poor resolution of letters and

numbers on the display screen directly contributes to this problem, HDTV could help.

JUDITH A. PERROLLE
 Boston, Mass.

Langdon Winner's assertions to the contrary, HDTV could indeed meet social needs. If the number of horizontal lines is doubled and the horizontal resolution improved accordingly, the amount of information that can be presented on a television screen increases by a factor of four. When I recently saw a demonstration of high-resolution TV, I found that I could read alphanumeric characters with striking ease. My friend in Switzerland has a new TV that can display "teletext" channels in German, French, and English; he can also command it to display detailed information on a variety of subjects.

I agree with Winner that not all technical innovations are worthwhile. Those that are worthwhile meet the needs of a progressing society—not so much because they do old things better, but because they create opportunities to do things no one ever conceived of before.

H.I. FLOMENHOFT
 Palm Beach Gardens, Fla.

ECOLOGY IN WARTIME

As an ecologist who worked for five years on the Atlantic coast of Nicaragua, I appreciate Robert Rice's excellent article "A Casualty of War: The Nicaraguan Environment" (*TR May/June 1989*). Given the military and economic pressures the Nicaraguan government has had to contend with for most of the 10 years since the Sandinistas came to power, it's quite remarkable that officials have been as concerned with environmental matters as they have.

I had occasion to witness this ecological concern when I returned to Nicaragua in January 1989 to coordinate some research on the state of the southeastern rainforest after Hurricane Joan. The Research and Documentation Center of the Atlantic Coast, an autonomous institution, solicited the

study. Government institutions requested several other such studies, and the government established an emergency committee to monitor the ecological effects of the hurricane and make recommendations.

Of course, the tension between the country's short-term need for foreign exchange and the long-term need for ecologically rational policies, so clearly reflected in Rice's article, could be seen in the wake of the hurricane. While the state forestry corporation was attempting to attract foreign lumber companies for salvage operations in the damaged forest, the emergency committee was arguing forcefully that foreign companies would go in only if the financial terms were made highly favorable to them and ecological regulations were lax. (As far as I know, no lumber extraction contracts have been signed.)

Incidentally, the ecological damage to the rainforest is probably not as bad as was first believed. In the areas we sampled, only 20 percent of the trees were left standing, but we were pleased to find that more than three-quarters of the trees, including broken and uprooted ones, had resprouted. Over 90 percent of the individual seedlings—as well as of the species represented—were primary rainforest trees, rather than the fast-growing, weedy kind that typically invade large clearings.

However, the economic losses from the hurricane were indeed staggering, as Rice notes, and went totally unrecognized by the U.S. government.

KATHERINE YIH
Cambridge, Mass.

NATIONAL SECURITY IN OUTER SPACE

As a long-time student of non-human intelligence, I can't resist commenting on Stephen Strauss's article about the International Astronomical Congress protocol for potential radio contact with extraterrestrials (*"Intergalactic Diplomacy,"* TR May/June 1989). While the protocol may strike the uninitiated as noble and worthwhile, it is in fact hopelessly naive. In my judgment, astronomers are permitted to

listen for radio signals only because military policymakers see this activity as harmless, and possibly because it makes a nice diversion from the much more interesting evidence already in the hands of our intelligence community—UFO sightings.

Regardless of whether one accepts the possibility that some UFOs may represent non-human intelligence (and surveys have indicated that many scientists and engineers do accept this), Freedom of Information Act lawsuits have liberated thousands of pages of documents showing that all branches of the U.S. military-intelligence community have displayed an ongoing interest in UFO sightings. The 40 years of controversy over such sightings have demonstrated that governments both here and in Europe view potential contact with advanced, non-human intelligence as having national-security implications.

Ever since the 1950s, the federal government has adopted a policy of public "debunking" to divert attention from UFO sightings. And you can't get federal money to study something government policy says isn't happening. Researchers in "search for extraterrestrial intelligence" projects, having received their government grants, are only too willing to play along. But in doing so they have made the Faustian bargain so familiar to nuclear physicists and Star Wars scientists. If they were sincerely interested in extraterrestrial intelligence, rather than just grant money for radio-telescopes, they would call for a broad-based research program that looks at all the evidence—even findings that don't conform to current notions about what intelligent life can and cannot do (interstellar travel, for example).

With a little editing, the International Astronomical Congress protocol might make a good screenplay for a low-budget science fiction movie, circa 1950. As a serious effort in the politics of knowledge, it is laughable and displays an ignorance of history and society.

TERRY HANSEN
Seattle, Wash.

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WILLIAM THE CONQUEROR AND AIR SUPERIORITY

In 1063 one of the most decisive battles in the history of the world was fought. William, Duke of Normandy, ventured an invasion of England in the face of a formidable opponent. But one of the reasons that gave him the confidence to try such a risky undertaking was that he had a recently invented technological edge that the English did not:

That edge was the stirrup.

While the English rode to the battlefield, they fought on foot; conventional wisdom being that the horse was too unstable a platform from which to fight. But the Norman cavalry, standing secure in their stirrups, were

Bayeux Tapestry, Anon. C. 1077, Bayeux, France



able to ride down the English, letting the weight of their charging horses punch their lances home.

This technological edge led to the conquest of Britain. Without it, William might never have attempted such a perilous war. And this very ad might have been written in Anglo-Saxon.

There are two lessons here, lessons that have been repeated endlessly throughout history. The first is that technological differences can lead to the rise or downfall of great civilizations. The second is that, emboldened by such advantages, a potential adversary may risk war.

The laws of history have not changed. In our own time we find ourselves jockeying for the technological edge. The Warsaw Pact is expected to produce an

air superiority fighter in the mid-1990s. This is where America's Advanced Tactical Fighter comes in. A culmination of the most far reaching technology in history, the ATF will effectively check a potential imbalance in air defense, and so preserve stability.


If, almost a millennium ago, the English had had some effective counter to the Norman cavalry, William might have had second thoughts about crossing the Channel. Applying that timeless lesson today, we know that defenses such as the Advanced Tactical Fighter will give second thoughts to anyone thinking that now is his chance.

 **Lockheed**
Giving shape to imagination.



MIT Reporter

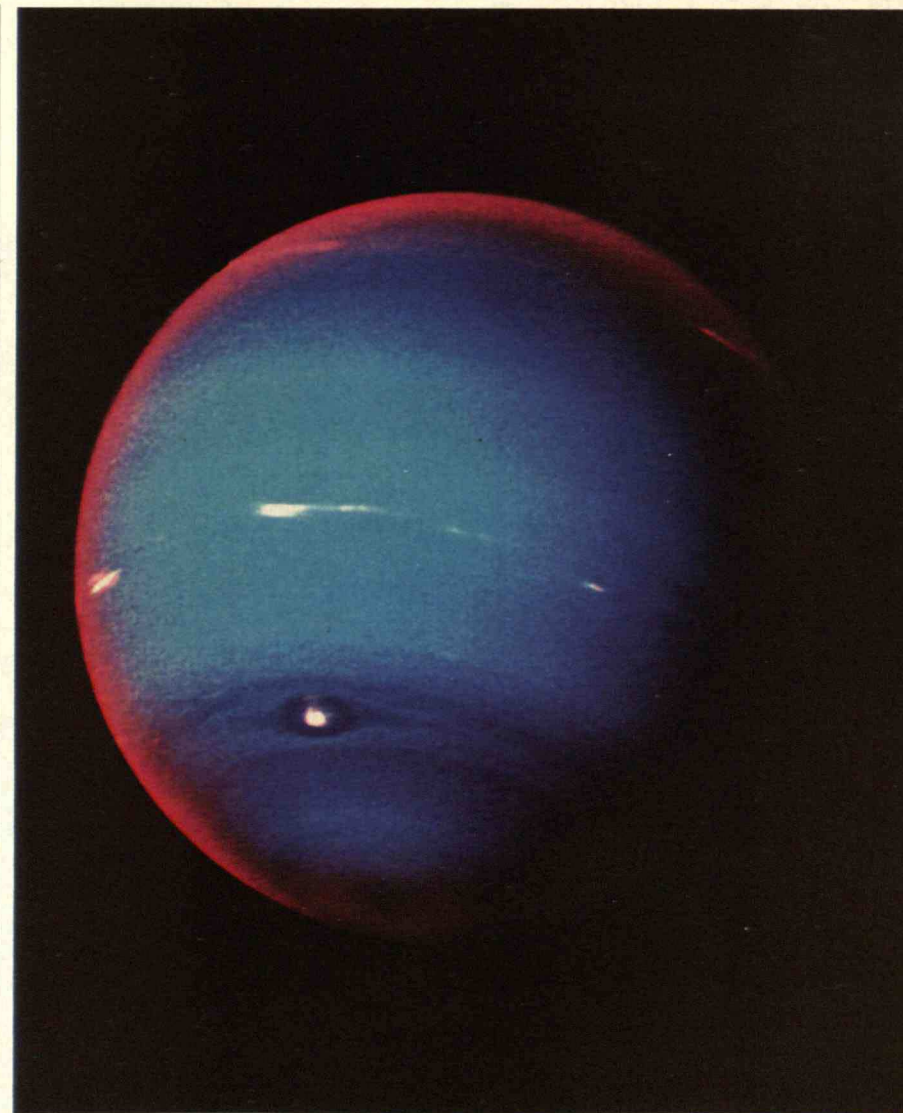
NEPTUNE'S MAGNETIC LOOKS

 When *Voyager 2* passed just 3,000 miles over the giant blue planet Neptune last August, most public attention focused on features that could be photographed: rings, clouds, and black streaks—signs of a special kind of volcanism—that run across the ultra-cold surface of the Neptunian moon Triton. Press accounts barely mentioned *Voyager 2*'s discovery and examination of Neptune's highly tilted magnetic field, whose poles lie about halfway between the planet's equator and rotational poles.

For Herbert S. Bridge, MIT professor emeritus of physics, this was the most exciting aspect of the flyby. During the last three decades Bridge has been building instruments to study the tenuous, supersonic "wind" of charged particles streaming from the sun. The devices also help researchers investigate the resulting plasma of ionized atoms and electrons trapped near the magnetic polar regions of most planets. Using a plasma-science instrument Bridge helped plan almost 20 years ago, *Voyager 2* became the first craft to probe the polar regions of a magnetosphere other than that surrounding Earth. Past spacecraft had rarely even traveled near magnetic poles, owing to rocket-energy requirements.

Voyager visited Neptune at the end of a 12-year "grand tour" that had included Jupiter, Saturn, and Uranus. The MIT plasma instrument had already observed the solar wind for more than one complete 11-year cycle of solar activity. Yet in some ways researchers had missed out. The timing of the 1986 reconnaissance with Venus, whose magnetic field also is tilted, had meant that the spacecraft was far from the magnetic poles.

Voyager scientists had to spend three years planning and compromising before they could agree to a special maneuver that made the magnetic-pole studies of Neptune possible. Although some experimenters were uneasy about the operation, the MIT group finally



convinced them to roll *Voyager* 61 degrees away from Canopus, a star by which the craft was navigating, and depend for a time solely on gyroscopes. That way one of the MIT experiment's four detectors could be pointed near the magnetic poles.

Off to the Terminal Shock

The MIT plasma instrument on *Voyager 2* is now on its way to explore the outer limits of the sun's influence. Before the on-board power supply gives out about 10 billion miles from the sun (sometime after the year 2010), the craft

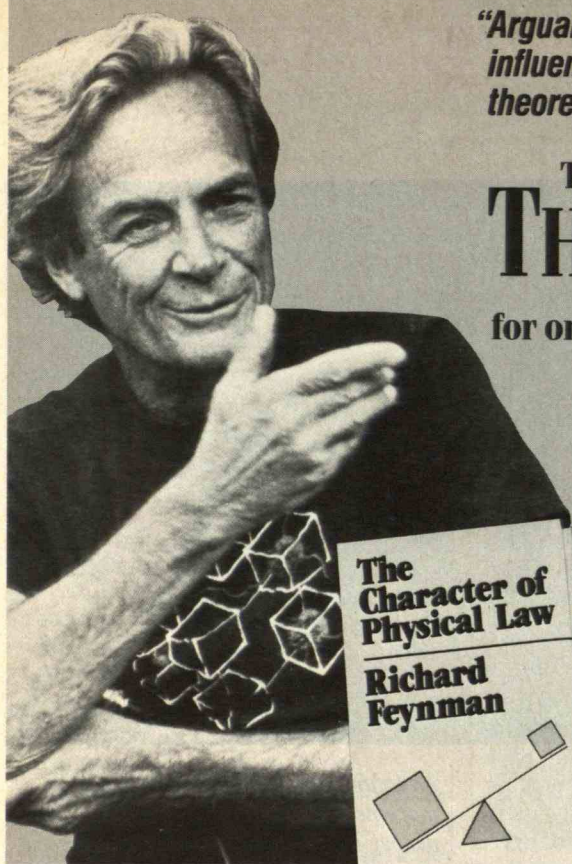
Last August, when Voyager 2 visited Neptune at the end of a 12-year "grand tour," the spacecraft became the first to probe the magnetic poles of a planet other than Earth.

could reach the region known as the "terminal shock," says MIT physics professor John W. Belcher, who supervises the research today. There the solar wind speed becomes subsonic as it runs into interstellar particle winds. This phase of *Voyager*'s journey will be a direct look at regions of space beyond those the sun dominates.

The MIT scientists are concerned be-

"Arguably the most brilliant, iconoclastic and influential of the postwar generation of theoretical physicists."

James Gleick, Author of *Chaos: Making a New Science*



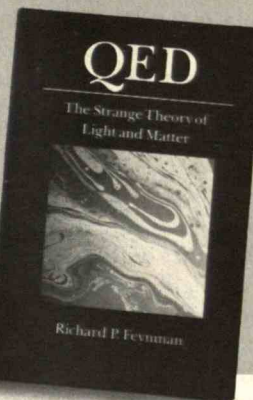
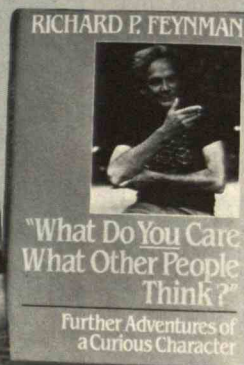
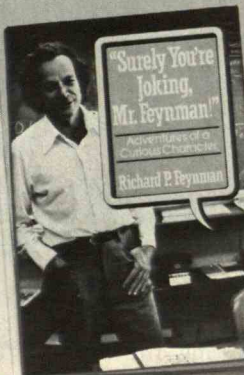
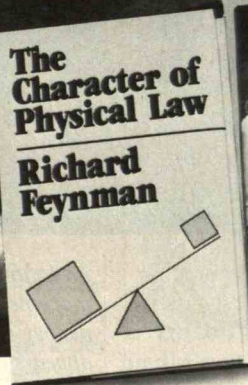
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The Strange Theory of Light and Matter

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The Character of Physical Law

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the elegance of scientific law... demonstrates the interaction of mathematics and physics... and much more. Don't miss one of Feynman's most insightful, entertaining performances, in a hardcover edition brought back into print exclusively for The Library of Science.

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"Surely You're Joking Mr. Feynman!" *Adventures of a Curious Character*

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"What Do You Care What Other People Think?" *Further Adventures of a Curious Character*

Once, when discussing the Challenger space shuttle disaster, Richard Feynman stated, "Reality must have precedence over public relations.... Nature cannot be fooled." Succinct and telling, these words describe the man whose interests, philosophies and, in particular, experiences as a member of the Presidential Commission investigating the Challenger explosion, are brought to life before your eyes. Written with long-time friend Ralph Leighton, this book is the legendary physicist's last literary legacy.

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Technology Review 1/90

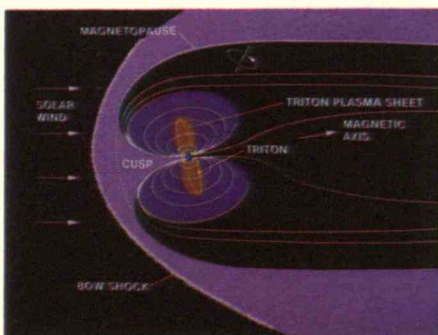
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cause, as the spacecraft moves toward the boundary between the solar system and interstellar space, the plasma instrument will go for several weeks at a time without gathering information because of practical logistics. For example, other experiments need to put data on the on-board tape recorder, and other spacecraft are demanding communication time on radio antennae on Earth.

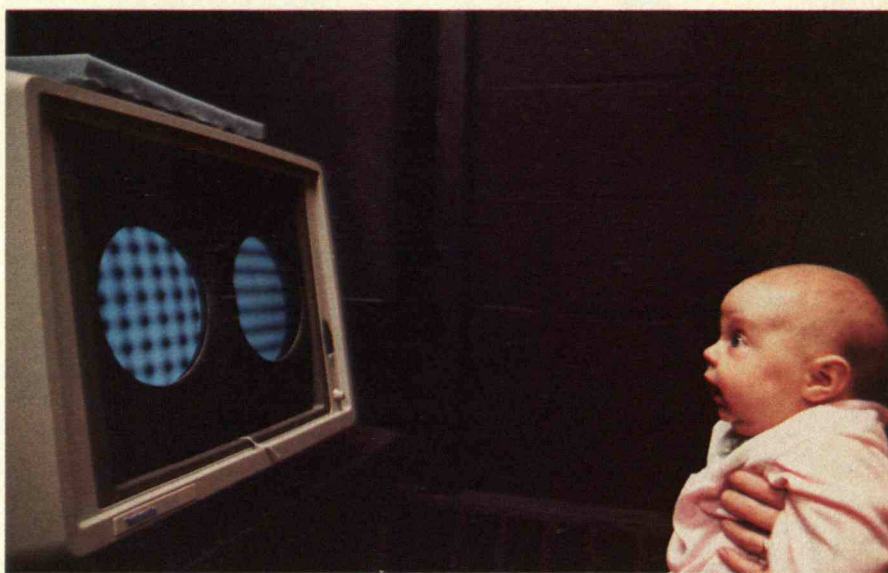
Meanwhile, space scientists are starting a phase of more intense planetary exploration. Spacecraft are about to orbit Venus, Mars, Jupiter, and Saturn for prolonged studies of their surfaces, atmosphere, moons, and magnetic fields. As a part of this, a team led by Gordon Pettengill, director of MIT's Center for Space Research (CSR), has developed an instrument that maps by radar. The device is aboard the *Magellan* spacecraft sent toward Venus in 1989.

And senior research scientist Alan J. Lazarus of the CSR is helping to plan the *Cassini* spacecraft mission that will go to Saturn around the turn of the century. Moreover, for the *Wind* spacecraft slated to orbit Earth in early 1993, Institute researchers are building an instrument that will measure the solar wind's speed, density, and temperature. ■


VICTOR K. McELHENY is director of the Knight Science Journalism Fellowships at MIT.




A "wind" of charged particles streaming from the sun flows around Neptune's magnetic field. The field's axis is highly tilted with respect to the planet's rotational axis.



TESTING BABY VISION

 Testing the sight of infants is tricky, since you have to get their attention, and even then they can't tell you what they are seeing. Professor Richard M. Held of brain and cognitive sciences has overcome the problem with a machine that tests infants for a wide range of visual functions. Babies as young as one month sit on a parent's lap and look at two round screens, one of which displays a changing line or dot pattern. The pattern becomes finer until the infant can no longer distinguish it from the neutral background on the other screen. When that happens, the child loses interest and looks away—giving the tester a measure of visual acuity. Held's lab is integrating the device with a computer that can record, analyze, and print out the results immediately.—WILLIAM J. CROMIE, *The MIT Report* ■

SCRAMBLING FOR RESEARCH DOLLARS

 As exciting as the current "end of the Cold War" climate may be politically, to many academics across the United States it doesn't look good for business. After a decade of growth to the highest levels ever in peacetime, the wave of Department of Defense (DOD) support for research seems to have crest-

An infant pays rapt attention to a machine that tests children's vision. When neither of the patterns on the two screens appears to change, the baby will grow bored and gaze elsewhere.

ed. Military dollars now account for a staggering two-thirds of all federal R&D allotments, and although no one knows how large a cut to anticipate or which fields will be hit hardest, academics fear a dearth of alternative sources to finance basic research.

In fiscal year 1989, DOD provided \$338 million to MIT's Lincoln Laboratory, and the Institute's share of Defense Department funds aside from the lab added up to \$48 million, or more than one-sixth of on-campus research expenditures provided by major sponsors. This proportion is dramatically higher than a decade earlier, when the federal government had not yet increased DOD money at the expense of other agencies. In 1979, military support accounted for just over a tenth of all research funds on the MIT campus. Another significant feature of the Institute's on-campus 1989 funding is that almost a quarter came from the Department of Energy (DOE) and NASA, which dole out some basic-research dollars for military programs.

Kenneth A. Smith, vice-president for research at MIT, predicts "significant" cutbacks in military funds for MIT in

fiscal year 1991. Less military spending may be "mostly marvelous for the country," he says, "but in the short term it will mean some dislocations and a fair amount of pain at the Institute."

Few Alternatives to DOD Money

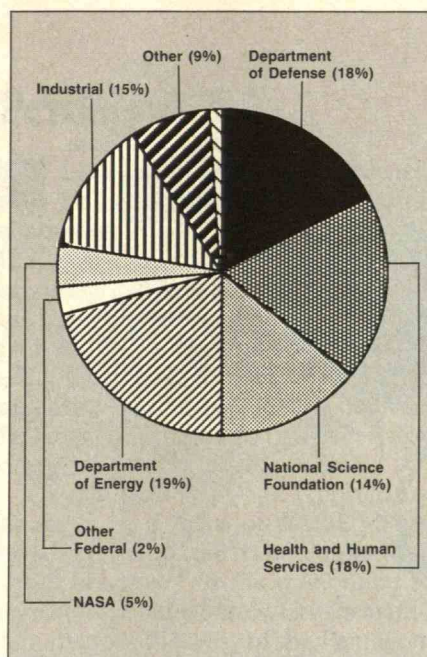
The situation is especially problematic at places like the Artificial Intelligence Laboratory, which receives more than three-quarters of its research dollars from the military. The Research Laboratory of Electronics (RLE) is also feeling the heat, since some 40 percent of its funds come from the Defense Department.

A related department that is vulnerable is electrical engineering. James Kirtley, an "e.e." professor and member of the faculty committee to investigate the military's impact on campus research (MICAR), says there are few sources of alternative funds to turn to. For example, he thinks prospects for more DOE money are "nonexistent" now that Congress has been tightening up the agency's budget in the wake of mismanagement at weapons-production plants.

MIT Provost John Deutch concurs with Kirtley's analysis. Around the Institute, "the reductions in Defense Department funds will likely not be compensated by other agencies like the National Science Foundation or the Department of Energy," he says.

Industry would seem to be the logical candidate to take up the slack. After all, corporate donations constitute the fastest growing source of research money at MIT. They were up 19 percent last year, overtaking the National Science Foundation as the fourth largest resource on campus.

However, administrators doubt that these funds will balance the loss, since industry typically steers clear of the open-ended studies the feds often sponsor. "There is still some tendency of industry to treat us as hired guns," observes RLE Director Jonathan Allen. Only IBM and AT&T Bell Laboratories have anything comparable to the fun-



In fiscal year 1989, more than one-sixth of MIT's on-campus research expenditures by major sponsors came from the Department of Defense.

damental research programs of the federal funding agencies, according to Allen, and "even [these corporate groups] are becoming more directed and short-range in their focus."

Relying on industrial support inevitably means some applied research, agrees James Melcher, a professor of mechanical engineering and a MICAR member who for political reasons has turned away from DOD and toward industry for funding. He adds that finding corporate dollars is no easy prospect today, because researchers have to maintain relationships with many companies.

A Chance to Increase Competitiveness?

Despite all the problems, Melcher and some other MIT professors believe that the reduction in military backing presents an opportunity. Melcher points to prospects for improving U.S. industrial competitiveness. Because of the substantial DOD funding since World War II, engineering students have become too insulated from civilian needs, he believes.

Kosta Tsipis, director of MIT's Pro-

gram in Science and Technology for International Security, says that the Institute could match "an emerging wealth of unusual talents with manifest civilian needs." This past December, Tsipis hosted a high-level group of corporate, academic, and military leaders to consider how industry could be encouraged to make up for diminishing military grants.

Still, MIT is bound to face "real problems in 1991," Kenneth Smith says. Despite some recent success in reducing the faculty's dependence on "soft" money (funds vulnerable to sudden cuts), Smith worries about the coming decrease in DOD dollars. "The most horrible thing about it is the uncertainty and arbitrariness involved. We just don't know who is likely to be most hurt." ■

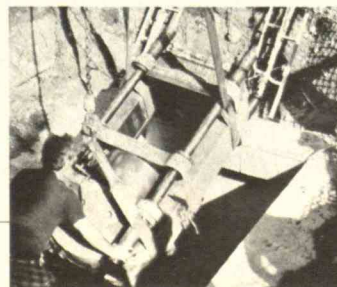
SETH SHULMAN is a frequent contributor to Technology Review.

MELTING ROCKS



Timothy Grove is playing Superman by melting rocks. "We want to try to understand where melts are produced in the earth's interior, and how that process results in the chemical layering we see in the earth's mantle and crust," says Grove, associate professor of earth, atmospheric, and planetary sciences. For his work he uses a hydraulic press that can recreate pressures and temperatures of the earth 400 miles down. But the recently acquired press is so heavy—almost 13,000 pounds—that it couldn't be moved along most floors at MIT. Workers had to tunnel into a passageway leading to a basement. ■

The press this worker is lowering into the ground is useful for studying deep-earth processes.



Trends



Quagga (*Equus Quagga*). 1/18 natürl. Größe.

DNA after Death

■ The natural-history museum is coming alive. Its old dead things—stuffed animals, skins, mummies—are suddenly a potential genetic treasure chest. Taking advantage of advances in molecular biology barely five years old, museums are beginning to decipher the DNA in the preserved flesh of their collections.

Genetic material may answer questions few believed would ever be resolved. "All of a sudden all those dried skins are not just artifacts," boasts Allan Baker, ornithology curator at Toronto's Royal Ontario Museum, which will soon remove DNA from such famous extinct beings as the great auk and the passenger pigeon.

Already researchers from the University of California at Berkeley have shed light on arcane issues of anthropology and zoology. Is the extinct hairy mammoth a closer kin to the African or Asian elephant? Do Florida Indians preserved in bogs have descendants among living North American Indians?

Resurrecting ancient DNA began in

The quagga, a cross between a zebra and a horse, has been extinct for over 100 years. Yet researchers can still resurrect DNA samples from it.

1984, when Berkeley microbiologist Allan Wilson and his colleagues retrieved bits of intact DNA from the skin of a dead quagga using a variety of separation processes. Hunters had wiped out this African animal, which resembles a cross between a zebra and a horse, over 100 years ago. The last quagga died in a Belgian zoo in 1883.

In 1985, scientists at Cetus Corp. in San Francisco developed a way to overcome the scarcity of DNA by multiplying a single piece of the material—the "polymerase chain reaction" technique. Later that year, Swedish researcher Svante Pääbo, then of the University of Uppsala, used these advances to extract the first DNA from a long-dead human—a 2,400-year-old mummified Egyptian baby boy.

By 1988, Pääbo had delved into pre-history, extracting DNA from the preserved brain of an Indian who was buried in a Florida bog 7,000 years ago. Subsequent analysis couldn't find that DNA in any known North Amer-

ican Indians, but the same patterns do appear among some living Japanese.

Recently, Russell Higuchi, then at the Wilson lab and now at Cetus, has not only extracted DNA from a 40,000-year-old frozen mammoth, but he has compared it to that of Indian and African elephants. Although the evidence is too weak for a definitive statement, it suggests the mammoth is more closely related to the Indian elephant than to the African one. The basis for that judgment is the "molecular-clock theory," which says that DNA mutates at a regular rate. Thus, the difference between two animals reveals when they separated from a common ancestor.

118 Million Dead Things

Resurrected DNA can also answer fundamental questions about evolution if several preserved creatures of a single species are available. At the Ontario Museum, Baker wants to extract DNA from huia, an extinct New Zealand bird. The museum has 15 of the roughly 50 preserved huia in the world. Many basic things are unknown about the bird, including where it fits on an evolutionary chain. DNA from the 15 Ontario huia should reveal whether the species pattern is similar to the genetic fingerprints of living birds.

Important facts are also emerging from a survey of 91 Indians preserved in another of Florida's many bogs. According to a University of Florida team, preliminary evidence suggests that DNA techniques will reveal the sex of bodies too young or too decomposed to otherwise determine. And analyzing all 91 Indians could answer other questions. "It may tell us



Svante Pääbo (left) has extracted DNA from a 2,400-year-old Egyptian mummy and from a Florida Indian buried 7,000 years ago.

how closely inbred they were," says anthropologist David Dickel, a member of the investigating team. "Did they marry people only within 25 or 30 miles?"

However, there are limits to DNA analysis. The Berkeley researchers and others have generally looked for mitochondrial DNA—which is found outside the nucleus of a cell—because it is perhaps 1,000 times as plentiful as nuclear DNA. If any genetic material survives, it should. However, only females pass on mitochondrial DNA, and consequently it reveals less genetic history than does DNA in the nucleus.

This is one reason that Michael Braun, a microbiologist at the Smithsonian Institution in Washington, D.C., plans to concentrate on reconstructing nuclear DNA in a genetic rescue program that started at the beginning of the year. Braun sees a huge challenge opening up with this project. "Given that we have 118 million dead things [in the Smithsonian], we have a ways to go," he says. But Pääbo estimates that with present technology, animals dead longer than 100 years are unlikely to yield analyzable undamaged nuclear DNA.

No one expects DNA techniques to ever let scientists take the ultimate step and reconstruct an animal—"That is about as likely as a monkey typing at random and making a novel," says Higuchi. Even so, a partial biochemical resurrection may be possible. If biologists identify a gene that controls a specific feature of living animals—color, for example—they might find its analogue in the DNA of extinct creatures. Thus, a bit of ancient quagga DNA could be inserted into a fertilized zebra egg.

The result, says Pääbo, might be a zebra that reveals the color patterns of a quagga. "But," he adds, "of course you would still not have the quagga." ■

STEPHEN STRAUSS is a science writer at the *Toronto Globe and Mail*.

Pentagon, Inc.

■ Late in 1988, a Defense Science Board (DSB) panel issued its controversial final report about how U.S. industry is to keep pace with that of other nations. Commissioned by the Pentagon to suggest a way to repair America's eroding technological edge, this group of business leaders and academics recommended that the Defense Department involve itself deeply in guiding civilian R&D.

Over a year later, the report continues to be a focus of debate about how to promote the technologies that could be crucial to the economic future of the United States. Critics maintain that the business of the Pentagon is defense, and that to make it responsible for commercial R&D is bad for national security and worse for business. Since almost all the panel members were tied to the defense industry, many critics also consider the report an attempt to protect funding for military contractors in an era of budget cuts.

Proponents of the DSB study counter that because the Pentagon is already playing an important role in civilian research, it is ideally situated to act as a U.S. version of MITI, Japan's Ministry of International Trade and Industry. MITI, which targets

about \$1 billion annually at key R&D areas, is widely credited for Japan's postwar economic recovery and international preeminence.

Through the Defense Advanced Research Projects Agency (DARPA), an effective yet relatively small agency, the Pentagon has underwritten progress on several "dual-use" technologies that combine military and civilian applications. With an annual budget comparable to MITI's R&D funding, the agency has long been the primary federal funder of university-based computer research. Currently, DARPA is contributing \$100 million to Sematech, an industry consortium mandated to help U.S. semiconductor companies compete with Japan, and providing \$30 million over two to three years to help develop high-definition television, another field in which Japan leads. DARPA is also distributing \$25 million to superconductivity research and many millions more to a variety of other projects.

One DARPA admirer is Jim Morrison, vice-president for policy of Business Executives for National Se-

The Defense Science Board has proposed that the Pentagon have a hand in guiding civilian R&D. Critics think this would be bad for national security and worse for business.





The V-22 tilt-rotor could take pressure off crowded urban airports. But the Pentagon is gearing the craft solely to military missions.

curity, which advocates a cost-effective, pragmatic approach to defense policy. Among other virtues, Morrison says, the agency tends to maintain a low profile, keep projects safe from interference by industry or Pentagon bigwigs, and "encourage prudent risks." In addition, DARPA rarely hesitates to "turn off technologies that aren't panning out and ramp up" those that are.

A Civilian Alternative

Morrison would prefer technological development by the private sector rather than the Pentagon. His second choice is a "CARPA," a civilian agency structured along DARPA's lines, perhaps based in the Commerce Department. He fears that if the Pentagon is in charge of industrial R&D, it will "pick technological favorites, pour a lot of money and prestige into them, and then be unable to turn them off if they don't work."

Bruce Merrifield, assistant secretary of commerce for technology policy in the Reagan administration and now a management professor at Wharton School of Business, also advocates a CARPA. In Merrifield's scenario, a Commerce-based agency would fund up to 20 percent of the R&D costs for

civilian technologies, if private investors put up the remainder. He considers this a good way to underwrite experimental projects for which risk capital would be difficult to raise.

According to Merrifield, such an arrangement would help an aviation-industry consortium develop the V-22 Osprey, a tangled Pentagon project that may be more useful for civilian needs. The V-22 is a "tilt-rotor" plane, powered by rotor blades on each wing. The blades face up like a helicopter's for vertical take-offs and landings and tilt forward during flight for greater speed. Budget constraints have led Defense Secretary Richard Cheney to suggest canceling the program, which would cost \$26 million per plane—four times more than the helicopters it would replace.

But an airplane that doesn't need a long runway might take some pressure off crowded urban airports, so the Port Authority of New York is lobbying Congress to save the Pentagon's Osprey and simultaneously develop it as a commercial craft. Faced with three jam-packed airports and no

space for new ones, the Port Authority has commissioned three studies to explore the idea of using the V-22 to transport commuters between small landing sites—even from downtown to downtown—or to shoehorn more flights into existing airports. Lobbying with the Port Authority are the project's Defense Department contractors Boeing Helicopters and Bell Helicopters Textron.

The lobbying has convinced Congress to back the military version of the Osprey. The Senate has asked the Pentagon to review the V-22's civilian potential, but neither Boeing nor Bell has pledged any of its own money to a commercial version—much less the 80 percent figure that Merrifield would propose. In fact, there is no clear picture of a program that would transform the V-22 into a commercial airplane and no estimate of how much it would cost.

As a result, Morrison feels that talk of the Osprey's civilian applications boils down to justifying a questionable military project. "If it's such a good idea, why doesn't private industry develop it?" ■

ANN MARIE CUNNINGHAM is a regular contributor to Trends, specializing in defense technology.

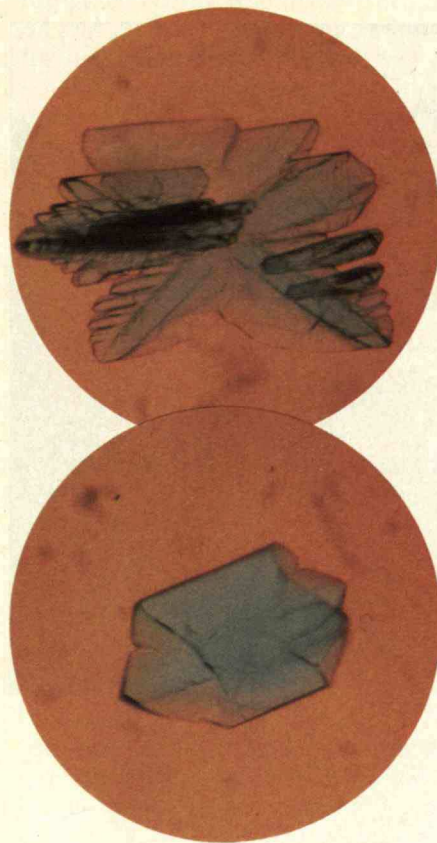
Crystal-Clear Drug Design

Pharmaceutical and chemical companies are looking to the heavens in their quest to decode the molecular structure of proteins, the engines that regulate biological functions. The early results suggest that basic materials research will be one of the first beneficiaries of using zero gravity. The reward could be valuable products for manufacture back on earth.

Experiments on the space shuttle are yielding protein crystals superior to those that are grown on earth. This could shave years off the time it takes to unravel the highly complex molecular structure of proteins. Such knowledge is critical to efforts to improve the way that new drugs are designed. As Cindy Zarsky of Merck & Co. in Rahway, N.J., explains, researchers working with an incomplete knowledge of protein structure can only "take pokes at" creating a new drug. "Pure rational drug design, from the ground up, has really never been done," she says.

Experiments in space are ending the dearth of good protein crystals to study, breaking a bottleneck that has long hampered x-ray crystallography. This approach showers crystals with x-rays to generate a picture of their internal structure. By analyzing the results, researchers can build precise three-dimensional models of protein molecules, providing information about how they function and interact with other molecules.

Recombinant DNA technology now makes it simpler to create pure proteins, and improved computers and three-dimensional graphics have also aided researchers. However, crystallizing proteins has remained a great challenge. Crystals are large, highly ordered arrays of molecules, and, in theory, any molecule with a regular structure can take this form. But many



Protein crystals grown on earth branch out like snowflakes (top). When grown in space, they tend to be much more regular (below).

proteins have resisted efforts to crystallize them, and attempts with others have been disappointing.

When grown on earth, some crystals take on a dendritic or tree-like shape such as that found in snowflakes. Dendritic crystals tend to be more disorderly than flat crystals, making them harder to analyze. The main culprit is gravity, which slows and distorts crystal growth, says Charles Bugg, who directs the Center for Macromolecular Crystallography of the University of Alabama at Birmingham. He has a NASA contract to coordinate research on growing space-based protein crystals.

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The results of experiments conducted on recent shuttle missions have been encouraging, yielding crystals that Bugg terms "bigger and better shaped." Patricia Weber, a research scientist with E.I. Du Pont in Wilmington, Del., reports that her company's attempts to crystallize isocitrate lyase on the shuttle *Discovery* in September 1988 have resulted in excellent progress. This enzyme is found in such organisms as nematodes, parasitic worm-like creatures that cause extensive damage to crops.

The Du Pont group has found that most of the dendritic tendencies of isocitrate lyase simply do not occur in zero gravity. "This was a major breakthrough," according to Weber. Thus, she says, her team's work may lead to better protection against nematodes.

In the long run, Du Pont and other companies hope to learn enough about the structure of particular proteins to discover how other molecules bind to them. This would be a step toward blocking specific proteins, which would help researchers move beyond the current scatter-shot ap-

In an experiment on the 1988 space shuttle Discovery, mission specialists George Nelson (left) and David Hilmer grew protein crystals in microgravity.

proach to drug development.

For example, Merck researchers have had some success growing crystals of elastase, an enzyme that helps break down elastic tissues such as those in lungs. The research could lead to an effective emphysema medicine if scientists can devise a chemical "key" that meshes precisely with elastase and "locks" it up, says Zarsky. "If we can fake out the enzyme by throwing it a dummy key, we can block the enzyme," she explains.

Still, Weber acknowledges that some scientists question whether space-based research is worth the enormous expense and effort it requires. But, she thinks, "The results are significant enough to make it worth a try. If it's successful, then it was worth it." ■

PHILIP BULMAN is a freelance writer based in Winter Park, Fla.

Perestroika and Energy

How will Mikhail Gorbachev's plan to restructure and stimulate the Soviet economy shape its energy system? Alexei Makarov, the leading Soviet energy thinker, has offered English-speaking readers rare hints of the long-term energy program being hammered out in high policy councils.

In the 1989 *Annual Review of Energy*, Makarov, director of the Institute of Energy Research of the Soviet Academy of Sciences, outlines a "new concept for energy development" that reflects the goals of perestroika. In the next 20 years, he believes, Soviet citizens could double their per capita personal energy consumption as housing improves and cars and consumer goods proliferate. Yet conservation and shifts away from heavy industry could substantially cut the economy's "energy intensity"—the amount of energy needed to yield a given economic output.

In fact, Makarov and like-minded economists and engineers have beaten the drum for energy reform for nearly 15 years, promoting conservation, increased electrification of industry, and less energy-intensive production. But official energy programs—like Soviet industry generally—have emphasized constant production increases.

"The result," Makarov writes, "is rapid depletion of existing productive capacities in the fuel industries (especially in the oil sector)." The Soviet Union has kept up energy production only by developing "less favorable deposits"—at skyrocketing expense—in remote regions like Siberia. According to Thane Gustafson, Soviet energy analyst at Georgetown University, the Soviet energy sector has absorbed over two-thirds of new industrial investment since 1975, severely constricting other investments.

Now, perestroika or not, the Soviet Union is ready to listen to arguments

like Makarov's as it runs out of cheap energy resources. The cost of finding and developing Soviet oil and gas reserves has more than doubled since the early 1970s, he notes. Environmental regulations will also increase costs, and nuclear power has been paralyzed since Chernobyl. Coal is also environmentally problematic and increasingly costly to produce.

Oil is especially worrisome, since oil exports earn most of the nation's hard currency. But oil output has peaked, and high production costs mean that exports are no longer the bonanza they were in the 1970s. Huge Siberian gas discoveries in the 1970s have helped, but also at high cost.

Postindustrial Vision

Makarov's prescription is a sweeping shift of priorities toward a "post-industrial economy" driven by services, consumer goods, and information technology, rather than energy-intensive heavy industry. "An active conservation policy" would reduce the economy's energy intensity by 28 to 30 percent between 1985 and 2000. At the same time, increased electrification of industry would more than double labor productivity. Industry's waste of materials and energy would be restrained, while energy-related pollution would be cut 25 percent by 2000 and 50 to 60 percent by 2010.

The restructuring and modernization of industry, Makarov says, could save the equivalent of 600 million tons of coal each year by 2000, and 1.8 billion to 2.1 billion tons by 2010. New energy-conserving technology could save hundreds of millions more. By 2010, national income could triple, with consumption of energy resources only 50 percent above current levels.

These gains in energy efficiency would curb the energy industry's voracious appetite for capital and labor—both in short supply. They would also provide energy to satisfy "the demand of the population for

top-grade energy resources," such as oil and gas for home heating and motor fuel.

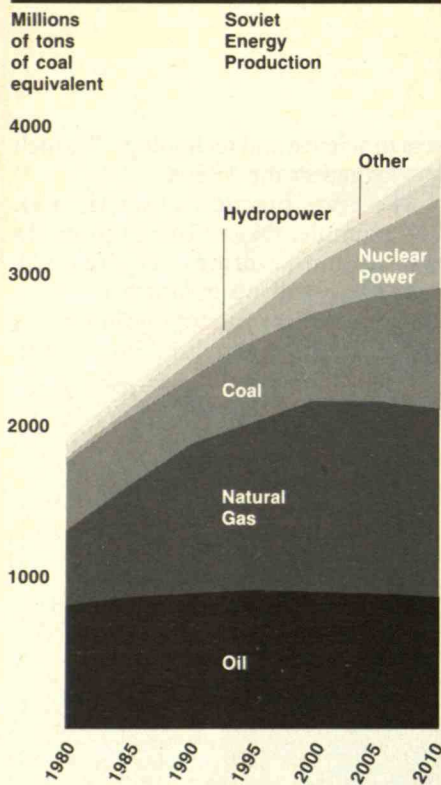
Of course, there is no guarantee that a postindustrial vision will be realized. Its ambitious technical goals are "unachievable," he warns, without "a marked acceleration of prog-

ress in science and technology," which has lagged in the 1980s.

There are practical obstacles, too. For example, raising energy prices to induce conservation—as Makarov proposes—will be inflationary in an economy where monopoly industries can pass price increases on to con-



When commissioned in 1990, this pipeline will carry natural gas to the western Soviet Union. But the cost of developing such energy reserves is rising.



A leading Soviet energy expert projects that his nation's income could triple by 2010, while consumption of energy resources would increase only 50 percent.

sumers. And recent events cast doubt on Makarov's projection that nuclear generation will increase more than threefold between 1985 and 2000.

Soviet planners' allocations of hard currency may also limit necessary purchases of foreign technology. There are already signs, says Gustafson, that leaders plan to invest less in energy than the 800 billion to 900 billion rubles that Makarov thinks will be required between now and 2000.

Nevertheless, the Soviet Union is struggling to ready itself for the twenty-first century. The very fact that Makarov's proposals are being published outside the Soviet Union shows that they are being taken seriously at high levels. It is increasingly clear—as Gorbachev keeps saying—that the old ways of doing things can't continue. ■

DUNCAN BROWN is a freelance writer based in Washington, D.C.

Truckin' on Down the Line

As truck manufacturers and operators face stricter clean-air regulations on the one hand and industry deregulation on the other, they are looking to technology for answers. Manufacturers want to keep truck prices low and engine mileage high. Truckers, scrambling for business in an increasingly competitive industry, want to offer faster and more reliable service.

Both industries are concerned about the tightening standards for diesel engine emissions. The Environmental Protection Agency (EPA) stipulates that trucks must reduce particulate emissions more than 80 percent by 1994. Nitrogen-oxide levels must be reduced over 50 percent. Some states, led by California, have even stricter regulations.

The burden for solutions falls on truck makers, who hope to meet environmental standards without dramatically changing the diesel that is central to their business. Arun Maira, a senior consultant in the automotive group at Arthur D. Little in Cambridge, Mass., says they are reluctant to equip diesel engines with particulate traps, which would remove the soot from diesel-fuel emissions.

The truck makers argue that such a trap would make a vehicle more costly and reduce engine efficiency. They are even less enthusiastic about switching to cleaner fuels, such as methanol, which is not widely available, costs more than diesel fuel, and would create complicated engineering problems.

Instead, manufacturers are trying to raise the efficiency of diesel engines. Thus, they are replacing the fuel injection pump—which regulates the fuel flow into an engine's multiple cylinders—with microprocessor-controlled unit injectors on each cylinder. Unit injectors can monitor exhausts

and more precisely "control the fuel as it enters each and every cylinder," according to Maira. Truck makers are also incorporating new materials, streamlining vehicle bodies, and tinkering with the design of turbochargers and pistons.

Still, Maira points out, "these are incremental changes. No one is foreseeing any major change in the process of combusting fuel." For example, last year Chicago-based Navistar International announced a prototype efficient diesel that burns low-sulphur fuel. It contains new injection and combustion systems, as well as some catalytic-converter technology. The Navistar engine "goes a long way to reducing [nitrogen oxides] and particulates," says Steve Albu, engineering-studies branch chief at the California Air Resources Board.

But, Albu adds, "it's just an interim solution." He thinks even "smokeless" engines such as Navistar's won't reduce emissions enough to meet EPA air-quality emissions standards for the year 2007. And he proposes even tougher standards to force the industry to adopt clean fuels. "We just don't have any other options left in southern California."

Dynamic Information

While the makers tackle the emissions question, the operators are dealing with competition by equipping trucks with computers and providing on-line delivery reports directly to customers. They are also contemplating keeping track of freight with satellites. And in the next decade, a radio tag on each vehicle might allow trucks to pass through tollbooths without stopping. The toll would be levied automatically, saving time and fuel.

Consolidated Freightways, Inc., of Menlo Park, Calif., one of the largest long-haul carriers, has already spent about \$300 million on computers to help manage its 39,000 trucks. The rudiments of its computer system to track and direct shipments have been



Navistar's "smokeless diesel" engine is designed to meet emissions standards. At Federal Express, a "digitally assisted dispatch system" (inset) is intended to beat competition.



in place for about five years.

Consolidated employees affix a bar code to every box and scan it at each step in the cargo's journey through 30 regional and 650 local freight terminals. Managers at each center know in advance what goods are heading their way, and where to re-route them. This helps Consolidated speed deliveries and better manage its own resources, explains Phillip Seeley, vice-president of management information systems. Moreover, customers can connect to Consolidated's computer for updates on where their goods are. Seeley says this especially serves just-in-time production lines, which rely on receiving parts on schedule.

Next, Consolidated plans to put computers equipped with radio transmitters on its trucks. This will link drivers—and data about the cargo they carry—directly to the main computer. Federal Express has had similar

computers in its fleet for several years. Federal Express finds computers cheaper and more efficient than cellular phones for communicating with drivers.

In the future, carriers could hook on-board computers into a dispatch system that could locate an available truck at any given moment. Eventually satellites might provide a continuous link between on-board computers and dispatchers.

"That on-board computer could also be plugged into the truck itself," Seeley adds. Among other tasks, it could monitor components such as brakes to help protect safety and schedule maintenance—and even check on each driver's performance. ■

THOMAS KIELY is a staff writer at New England Business and a regular contributor to Technology Review.

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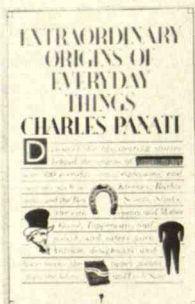
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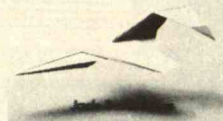
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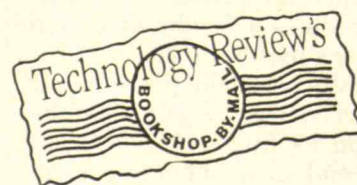
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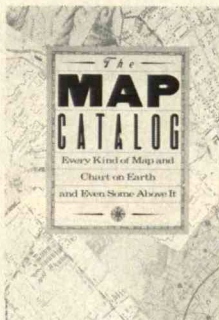
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The Future of the U.S. Aircraft Industry

BY ARTEMIS MARCH

FROM the end of World War II into the 1980s, U.S. manufacturers enjoyed a virtual monopoly in commercial aviation, as pilot-managers who love flying actively exploited a unique historical and political situation. However, the U.S. position has been declining and is likely to slip further. The ingredients that led this country to dominate the aircraft industry have disappeared, forcing firms to work uphill in international markets.

The legacy of World War II was production capability, project management, and engineering skills, and rather than coasting on those assets, U.S. aviation companies built on them. They thought long-term, developed global products and product support, and repeatedly bet their companies on major technological jumps. For example, the gigantic 747 nearly took Boeing and Pratt & Whitney under in the early 1970s; Lockheed lost its bet first on the turboprop Electra in the mid-1950s, while Boeing and Douglas moved into the jet age. Later, the

*A*midst a
dramatically
changed
environment
at home,
U.S. aviation
manufacturers
face a serious
challenge
from abroad.



head-to-head competition between the DC-10 and the Lockheed L-1011 split the business, so neither could profit. Lockheed dropped the L-1011 in the mid-1980s, having lost its second bet.

Such willingness to take risks was part of what John Newhouse calls the "sporty game," played by people who loved building and flying airplanes. Technology-oriented airlines drove and supported like-minded airframe builders, and both pushed engine builders.

At the same time, the U.S. government supported civil aviation and aviation technology, especially on the market side. The post office's commitment to air mail during the 1930s laid the foundation for passenger service, and, most important, regulation by the Civil Aeronautics Board (CAB) made it possible for airlines to demand cutting-edge technology.

Under regulation, the government controlled fares, routes, and the entry of new airlines, so competition centered on performance and service. If one airline bought advanced planes, competitors had to get them. When Pan Am 707s cut three hours off intercontinental flights and reduced seat costs per mile 30 percent, other airlines needed updated fleets. Thus, American placed 707 orders right after Pan Am. Because the costs of new technology could be passed on to passengers, manufacturers were not particularly constrained to be efficient. Still, the industry assumed that technology-based productivity improvements made up for the cost of developing and applying them.

Military projects helped by funding and testing high-risk technologies, underwriting development of the jet

*Until deregulation,
the government
controlled fares,
so airlines competed
on performance
and service.*

engine, and ordering planes that could be converted into transports. Defense Department orders that eventually totaled over 800 for the KC-135 cargo plane brought down costs for Boeing's 707, the first successful commercial jet. Similarly, government purchases of military versions kept the Boeing 747 and Douglas DC-10 production lines open.

By contrast, postwar European manufacturers were fragmented and poor. They designed for their domestic airlines rather than global markets and did not match Boeing's

global product support. Moreover, war treaties prevented Germany and Japan from rebuilding their aviation industries for many years.

This constellation of factors is gone forever, and with it the U.S. monopoly. Competition is fierce, and will get even more intense, in part because manufacturers produce and support twice as many models as they did a decade ago. Furthermore, European nations have rebuilt their economies and formed Airbus Industrie, an effective consortium that is building and marketing products worldwide. The enormous financial risks in the industry have already winnowed out most U.S. contenders, leaving only Boeing and McDonnell Douglas as airframe manufacturers.

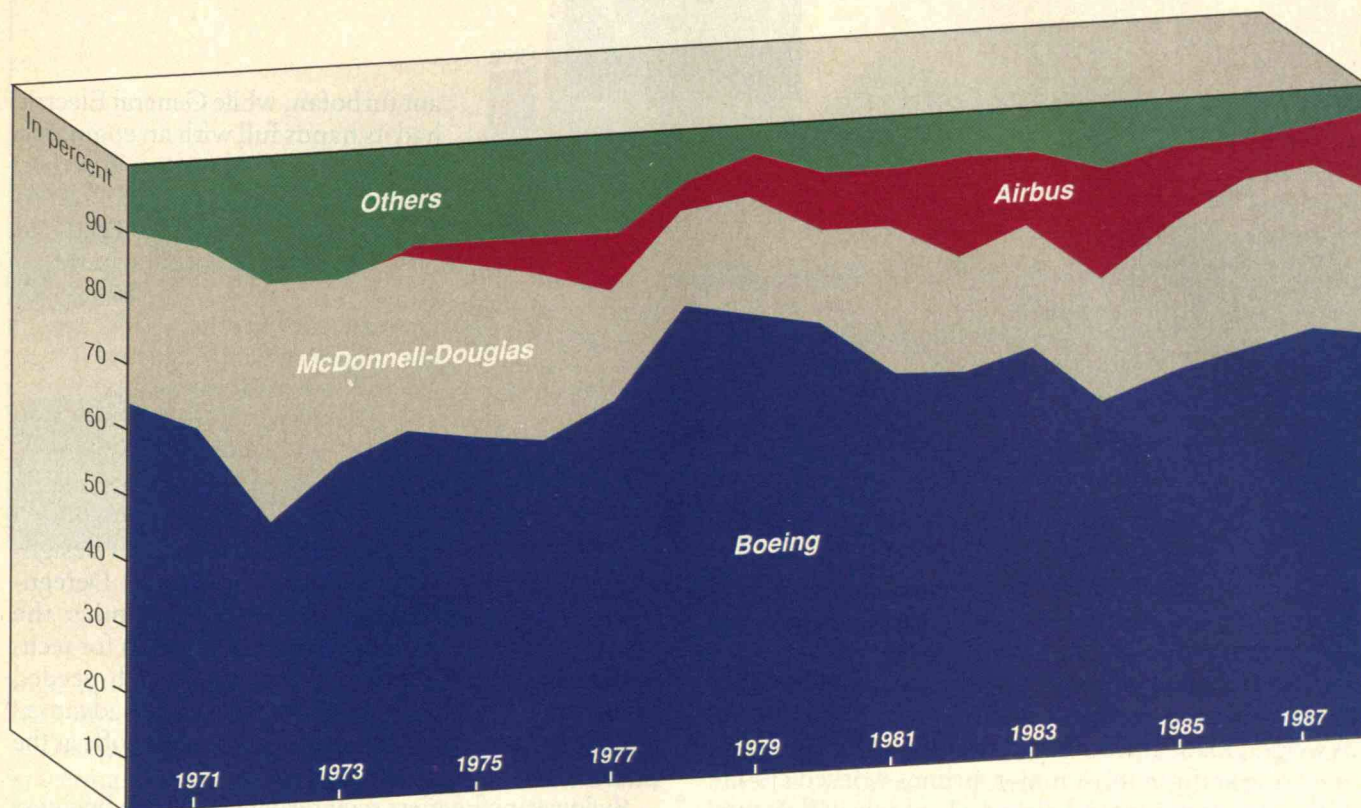
In addition, direct military-commercial transfer has declined considerably, particularly for airframes, and will continue to do so as mission requirements diverge and fewer military programs start. One casualty is validation—the process of testing new advances. The longest and costliest stage in developing technology, validation has become the weak link in the R&D chain. The military is doing much less of it, and NASA is not filling the gap.

The technological basis on which U.S. airframe and engine manufacturers traditionally competed is still critical, but it is no longer nearly enough. They now face a complex international environment that has diminished their technological edge, reduced engineering-based relationships with their customers in favor of financially dominated ones, and accelerated the globalization of production and marketing. Even in the current growing market, sales go to those firms that can expand production most efficiently.

ARTEMIS MARCH is an independent management consultant based in Watertown, Mass., and was a staff member of the MIT Commission on Industrial Productivity. She received her doctorate in sociology. She conducted the commission's studies of the aviation and machine-tool industries and has developed over 25 case studies for Harvard Business School and the Center for Executive Development, where she is a senior associate. Her areas of work have included global competitive strategy, manufacturing strategy, supplier relationships, and process-driven product development. This article is adapted and excerpted by permission of the publisher, The MIT Press, from *The Working Papers of the MIT Commission on Industrial Productivity* (1989).

Market share: Boeing, McDonnell-Douglas, Airbus

Percent of deliveries from 1970-1988

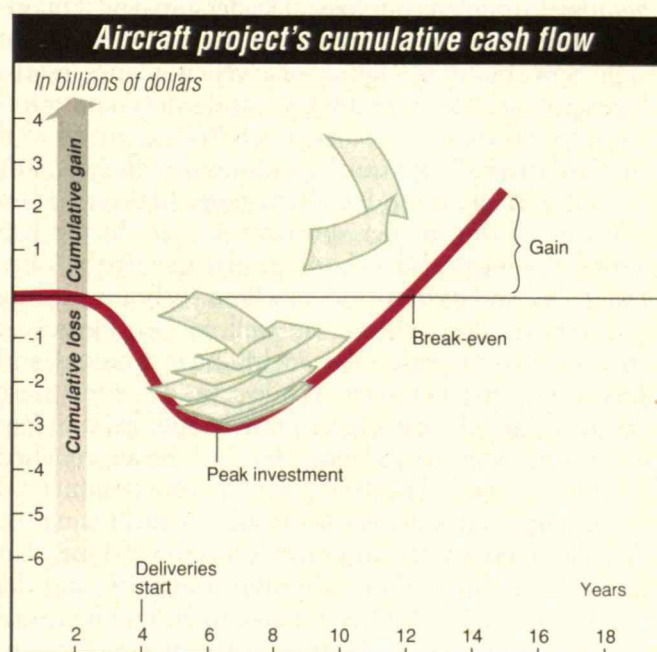


A High-Tech Tradition

What sets the aviation industry apart from all others is the enormous economic and technological risk it entails. Every new model, or even a derivative, incorporates many technologies that must work together safely and reliably. And that product must combine a low enough price with high enough performance to convince airlines to adopt it. The launch costs for a new aircraft run \$2 billion to \$4 billion. Six hundred units must be sold for a model to break even. Cash flow is negative for at least 5 years, and break-even—if it occurs—takes up to 14 years, with wide swings in demand during that time. Engines, the pacing technology for new generations of planes, cost at least \$1 billion to develop and require about 2,000 sales over 10 years to break even.

Since it takes so long to develop, test, and certify airframes and engines, and both have 20 or more years of service life, launch decisions are taken with a 25-year perspective and under conditions of great uncertainty. As a result, commercial aviation has been marked by tight working relationships between manufacturers and

Airbus deliveries and production rates remain low, but orders have shot up and its planes have become a viable choice for airlines. Most important, the European firm has the financial resources and staying power to produce new models (below).





those airlines whose early orders get a project off the ground.

An aircraft program is officially launched after two or three customers commit to purchase a certain number of planes. The manufacturer then designs a transport to meet the multiple and conflicting demands of these launch customers. In return—at least in the past—the customers have made advance payments of 20 to 30 percent of the launch costs.

Until recently, ties between the engineers of both groups lay at the heart of the manufacturer-airline relationship. Airframe engineers spent thousands of hours coming up with design trade-offs to reconcile conflicting customer demands, keeping in mind such interrelated parameters as weight, load, and aerodynamic efficiency. Strong engineering staffs at most major airlines worked closely with manufacturers and played a lead role in fleet purchase decisions. The airline engineers evaluated the designs, suggested alternatives, and made cases for the ones they believed fit their employers' needs.

In this context, Boeing established its commercial hegemony through technological leadership, and it maintained its position by having the right product at the right time, building a family of excellent planes, establishing a reputation for integrity and safety, and offering unparalleled product support. Boeing introduced the 707 in 1957 and quickly followed with two mid-size 727s for short- and medium-range flights and two versions of the smaller short-range 737. In the late 1960s, Boeing took a technological leap with the long-range 747 and its powerful new Pratt turbofan engine.

In short, the airlines—as well as key figures at them—played a critical role in driving technology and providing a market for it. While several carriers were frequent launch customers, Juan Trippe, head of Pan Am for decades, was a leader. In 1952, he approached Boeing and Douglas about developing a commercial jet. Boeing responded enthusiastically, producing the 707; Douglas was less responsive. In 1965, Trippe went to the same firms about a jumbo transport, and the result was the 747. When it came to designing an engine for the jumbo jet, Pratt was eager to develop a gi-

ant turbofan, while General Electric had its hands full with an engine for the C-5 military transport. Together, Trippe and Boeing pushed Pratt to a level of performance that Pratt had been uncertain it could achieve.

*The
diminishing role of
technology in U.S. aircraft
manufacturing
could have major
long-term economic
implications.*

**Deregulation Erodes
the Technological Edge**

The 1978 deregulation of the airline industry unleashed a chain of events, at the center of which was the displacement of technology for its own sake as the major factor in designing and choosing aircraft. Deregulation has made economics the determining consideration for tech-

nology, and while this has encouraged much-needed manufacturing excellence, it may crowd out advances that do not demonstrate strong economic payoffs at the outset.

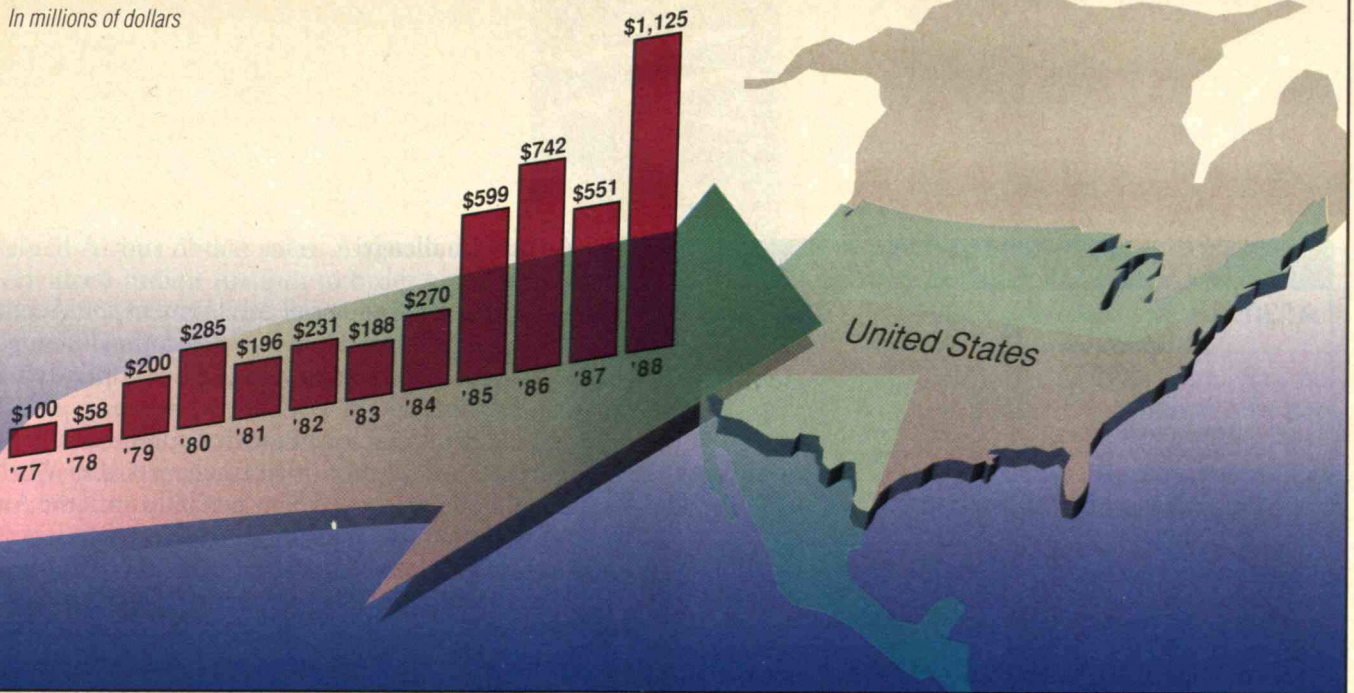
By lowering barriers to entering the airline business when the supply of used planes was ample, deregulation made it harder for established airlines to become launch customers and finance innovation. Fledgling airlines established themselves cheaply, offered lower fares, and cut into the earnings of the majors. Price competition—combined with higher fuel costs in the late 1970s, weak earnings, and the Reagan recession—put pressure on the majors to save money, a painful process that often included wage rollbacks and labor renegotiations.

Many of the new airlines were not in the market for expensive new planes, and they quickly forced the majors to hold off on significant commitments. Then, in the early and mid-1980s, mergers, volatile earnings, lower fuel costs, rising prices for new aircraft, and the continued surfeit of used planes further slowed replacement purchases.

Deregulation has also reduced technology pull by destabilizing route structures and strategies. Without stable routes, airlines are less inclined to make the 20-year fleet commitments they need to become launch customers. Leasing has become attractive, not only for economic reasons at shaky airlines but also for fleet flexibility at larger and stronger ones. American Airlines gave the first big impetus to this trend by leas-

U.S. imports of large transport aircraft

In millions of dollars



U.S. aircraft manufacturers are facing intense competition from abroad, and the financial risks in the industry have already winnowed out all but a few American firms.

ing, rather than buying, 20 McDonnell Douglas MD-80s in 1981.

Deregulation has also hastened the decline of engineering, previously central to the strong customer pull for technological progress. During the past decade, severe cutbacks in engineering staffs, especially at TWA, American, Pan Am, and Eastern, have made the close coupling between manufacturers and airline engineers almost a relic, so airlines are less able to provide the ongoing evaluations that manufacturers have counted on. According to a Boeing general manager, his firm "used to hear primarily from the engineers about what to buy. Now [the heads] make the deal, and then call in the engineers to get all the options they can within certain dollar limits."

In the past, safety was the key factor limiting the introduction of technology. Now manufacturers want assurance that a substantial investment in product and process technology will realize economic benefits for the airlines who are potential customers. Advanced performance has to be translated into direct economic benefits. And still the airlines may not buy: since 1984, three new planes—Boeing's 757 and 767 and the Airbus A310—have sold slowly while many airlines rely on heavily depreciated craft. Robert Martens, American Airlines' vice-president for financial planning and analysis, has summarized the new hard line: "What we are prepared to pay bears no necessary relationship to [the] costs of engineering and manufacture."

One result may be greater testing of developments

to minimize economic risk. More important, manufacturers may be reluctant to innovate, and Boeing's postponement of its plans for an all-new, 150-seat 7J7 may reflect a fundamental question: is it economically feasible to build such a sophisticated plane for such a small payload?

Of course, an economic filter is not entirely bad, since manufacturers now try to build the most efficient machine. Many innovations cut fuel consumption—weight reduction, efficient gearboxes, improved lift/drag ratios—while others lower costs over the life of a plane or engine. For example, composites and other novel materials that make engine components more reliable also reduce maintenance and replacement costs. Design commonalities among models decrease development and production costs and lessen the time it takes to train crews and maintenance personnel.

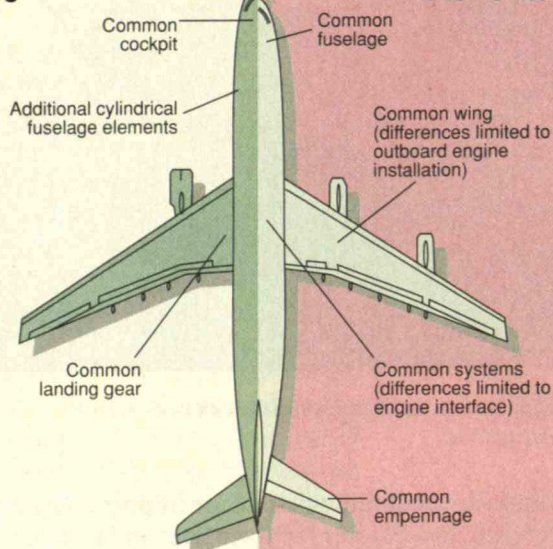
Still, the diminishing role of technology could have major long-term economic implications. A large aircraft represents the complex integration of an enormous number of advanced technologies—including power plants, computers and digital avionics, esoteric metal and nonmetal materials, aerodynamic structures, and sophisticated design tools and manufacturing processes. While the United States retains broad leadership in many of these areas, that is being challenged.

Thus, the Aerospace Industries Association (AIA) is concerned about America's "eroding competitive and technological edge." The current U.S. trade surplus in aerospace products draws on technology that is 10 to

Airbus A330/A340 commonality

A330

A340-200



By designing different models with common features, Airbus cuts down on production costs.

25 years old, and the situation regarding process technology is even bleaker. At the same time, other countries have greatly increased their aviation research. According to the Office of Science and Technology Policy, "In a growing number of aviation-related areas, foreign technical capabilities are now comparable, if not superior, to those of the U.S."

In the critical case of engines, the United States remains preeminent, with Pratt & Whitney and GE sharing about 80 percent of the market, but many foreign firms are participating as junior partners and subcontractors. Both engine and airframe manufacturers increasingly rely on such partnerships to reduce risk, tap sources of capital, penetrate markets, and compete for share.

Through these arrangements, technology is diffusing more rapidly around the world. A prime beneficiary has been Japan, which has expanded its airframe and engine expertise in a series of military and commercial ventures with the United States. American partners try to structure the agreements to protect the newest technology, but these may be Faustian bargains in the long run.

The Airbus Challenge

Japan's approach to industrial development could eventually pose a significant threat to U.S. aviation manufacturers. For the present, however, the competition is based in Europe.

European firms developed the first commercial jet—the Comet I—and various other transports after World War II, but none succeeded commercially until the Airbus Industrie family. Typical of the aircraft business, that success has come only after years of effort and a \$12 billion to \$15 billion investment. The consortium sold virtually no A300s for four years after introducing the craft in 1974 but continued to build and carry planes as inventory for months and even years. When orders picked up in the late 1970s, Airbus could offer immediate delivery, and, it is often alleged in the United States, made highly attractive financial deals with customers. In 1977 Eastern became the first U.S. customer, followed by Northwestern, Pan Am, and American. By mid-1987, Airbus had delivered \$21.9 billion worth of airplanes and had a \$12 billion backlog.

Airbus's organizational structure has given it the resources and decision-making mechanism needed for commercial success as well as technical achievement. Although composed of companies in France, West Germany, the United Kingdom, and Spain, Airbus provides single-point marketing and customer support for its planes. Each partner is responsible for financing, R&D, design, and manufacturing components, with final assembly in Toulouse, France.

Unlike the U.S. experience, governments, not private companies, bear most of the tremendous risk and working-capital needs. Airbus firms go to their home governments for loans and grants to fund both development and production; so far, they have not been turned down. British Aerospace, for instance, received \$725 million from the British government to design and develop a common wing for the A330 and A340, whose payload and range place them a notch or two below the 747.

U.S. producers contend that such subsidies violate the General Agreement on Trade and Tariffs because there is no expectation of repayment. Moreover, the Americans allege, Airbus benefits from political horse trading. According to congressional testimony, French investment in a Kuwait petrochemical plant and the decision to grant the Koreans landing rights in Paris have



helped Airbus obtain sales. Airbus convinced Indian Airlines to order planes even after the latter had signed a letter of intent with Boeing; at the same time, France offered India support for World Bank loans, accelerated delivery of Mirage jets, and provided technical assistance in cleaning up the Ganges River.

Airbus rejects the charges, stating that it aims to gain the 30 percent market share necessary to become self-sustaining. The consortium claims that subsidies are required to right the trade distortion of a U.S. monopoly, and it points out that none of its commercial products are military derivatives. Airbus countercharges that military support aids the U.S. aircraft industry. To back that up, it has mounted a two-year study documenting \$23 billion in subsidies to Boeing and Douglas over the past 10 years. Airbus complains as well that Boeing reaps excessive profits from the high-priced 747, which has no direct competition.

Amidst the sea of charges and countercharges, two points should be highlighted. First, given this industry's role as a driver of product and process technology, the prestige that countries attach to being in the business, and its role in maintaining an industrial base, nations that elect to participate *must* assist producers. Second, the effects of different forms of government aid are difficult to compare, since much U.S. advanced technological work is classified, European governments and Airbus partners are reluctant to fully account for their financial arrangements, and the IRS pressures U.S. contractors to separate military and commercial jobs.

Airbus and Technology

While government assistance gives Airbus the ante to enter this high-stakes game, the consortium would not have begun to succeed without a good product and strategy. Having come late to the game, Airbus had to convince the airlines to pay the enormous costs of switching to a supplier with no track record.

Airbus has made technology leadership its cornerstone. For example, it has aggressively used composites in vertical fin and control surfaces to reduce weight. The Europeans, who are doing extensive composites

*Following the
U.S. pattern,
Airbus has
made technology
leadership its
cornerstone.*

research of their own, have also drawn on NASA work and applied some of it more extensively than have U.S. manufacturers.

However, Airbus managers believe that such technical advances must go hand in hand with reducing production costs and rethinking the ties between design and manufacturing. The partners have invested heavily in flexible automation and computerized systems, and these efforts are increasing productivity. When Airbus decided to use composites, Messerschmitt-Bölkow-

Blohm, the German partner, redid the fin design and lowered the number of parts from 2,000 to 100. This reduced the price of the fin, despite higher material costs and the relative expense of machining composites.

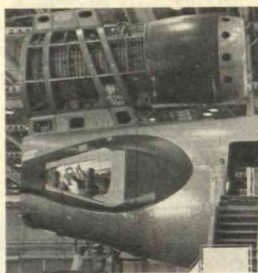
Airbus has also led in applying several safety-oriented systems, such as automatic wind-shear protection and digital flight controls. These make it impossible for a pilot to go outside the flight envelope—for example, by flying too high—and at the same time they make it easier to push the aircraft to its limits. Should the pilot make a violent maneuver that could stall the plane, the system compensates automatically.

Such innovations have been critical, even though the U.S. share of the transport market remains commanding. While production rates and deliveries have remained low, Airbus orders, led by the new 150-seat A320, have shot up, and a long-planned increase in production capacity is under way. Airbus orders surpassed Douglas's in 1986 and are cutting into Boeing's share. American products still make up 85 to 90 percent of the deliveries, but the two-way international trade in aircraft parts, engines, and engine parts is accelerating.

Underlying such statistics is the reality that Airbus has established itself as a viable choice. That bolsters the bargaining power of airlines, diminishes Boeing profits, and forces Douglas to compete on price. All these factors reduce the funding for technological development by U.S. firms.

Preserving a U.S. Industry

Excellence in operations, in managing supplier relations, and in transferring information and technol-



*A*irbus success
diminishes Boeing
profits and forces
McDonnell Douglas
to compete
on price.

ogies among groups has become, if anything, more critical during the current boom in orders at all the airframe manufacturers. The enormous backlog has strained the capacity of all the airframers and many of their suppliers, and it has revealed the depth of quality problems and the need for much better trained people. The era of automatic U.S. dominance in aviation is coming to a close. The new era demands world-class performance not only in the product but also in manufacturing. Fortunately, the leading U.S. aviation companies have developed a growing appreciation of the need for design-manufacturing excellence.

General Electric has turned its attention toward increasing productivity, focusing on design and engineering as well as labor. Satellite plants develop their own initiatives, while central groups for advanced engineering and advanced materials are working more closely with each facility to improve the transfer of technology to them. Also, more use is being made of design-to-cost throughout the engine business.

During the past few years, Douglas has been reorganizing manufacturing by using group technology to simplify routings, cluster work into cells, and reduce material handling and inventory. Believing that it can't afford to reinvest massively in fabrication, the company is making selective investments in assembly and testing and may subcontract more operations. For example, rather than modernize its sheet-metal shop as Boeing is doing, Douglas might opt to subcontract much of this work. In 1989, Douglas undertook a massive shift from a functional to a product organization, but this rocky transition has not yet borne fruit, and Douglas has been plagued by production problems and delays.

Pratt has determined that it must reduce its high business costs 30 percent by 1992, which will mean substantially cutting salaried personnel. It has separated large-engine production into three groups (commercial, government, and operations), dividing engineers among them to pay better attention to divergent customer needs. The service business has become a separate division to address Pratt's badly deteriorated reputation in that area. The company is also creating decentral-

ized groups organized around generic parts (such as compressor parts), and it is regrouping equipment to drastically cut materials handling, inventory, scrap, and rework.

Unfortunately, most of these initiatives are within the parameters of existing production systems. By contrast, Boeing's effort to slowly reorganize itself and its relations with suppliers appears to be a much more ambitious attempt to change its culture and ways of doing business. Its objective is to turn a schedule-driven business into a quality-driven one and, in the process, drastically cut costs and development time. Activi-

ties having the biggest potential payoffs are receiving the most attention. For example, design-build teams, composed of people from every relevant function, aim to do things only once—that is, achieve a single drawing release by making trade-offs based on getting everyone's requirements beforehand. Major process and computerization investments are being made as part of broader revisions in the organization of work rather than as stand-alone investments. Also, extensive quality-focused dialogues with suppliers are an attempt to alter the entire cultural context in which business relationships are forged.

By the mid-1990s, Boeing may be well positioned to meet the challenges from Europe and the Far East. Still, even its product and market sizing and timing have slipped, especially on the 757. Boeing has continued to modify the 747 and 737, but it has downgraded plans for the 7J7, which was originally intended to technologically leapfrog over the Airbus A320 in the early 1990s. In fact, Boeing's direction and strategy are less clear than they've been in a long time, even as Airbus repeats key elements of Boeing's tradition of technology leadership and product family.

There is one encouraging development for the U.S. aviation industry. Because the opportunities for exploiting aeronautical technology are still enormous, the Aerospace Industries Association is mounting its own effort. It has forged an industry consensus around eight key technologies, including sensors, propulsion systems, and artificial intelligence and advanced composites. Through testimony on Capitol Hill and meetings

forced case: $y'' + y + \varepsilon y^3 = \varepsilon \delta \cos(t)$

$$y \sim \frac{36}{3} \delta \cos(t) + \frac{\varepsilon}{72} (-\cos(t) + 3 \cos(3t)) + \dots$$

control pitch thru $\vec{u}: \vec{y}' = A\vec{y} + B\vec{u}$

$$TFM_{1,1} = \frac{\alpha}{s^3 - 2s^2 + s - 2\alpha}$$

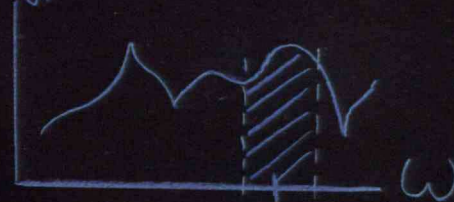
$$\left[\begin{matrix} \text{Matrix} & t \\ e & \end{matrix} \right]_{1,2} = \frac{6e^{5/2}}{\sqrt{33}} \sinh\left(\frac{\sqrt{33}}{2}t\right) \text{ from Macsyma}$$

$$-pr((v^2)^2 + \sin^2(\theta)(v^3)^2) + \frac{\partial p}{\partial r}$$

$$+pv'(2\frac{v^1}{r} + v^2 \cot(\theta))$$

$$+v'(v^1 \frac{\partial p}{\partial r} + v^2 \frac{\partial p}{\partial \theta} + v^3 \frac{\partial p}{\partial \varphi}) + \text{VISCOUS TERMS}$$

|TFM_{i,j}|



$$\text{Fourier}[\sin(t)] \rightarrow \frac{2}{\pi} \left(1 - \sum_{n=1}^{\infty} \frac{(1+(-1)^n) \cos(nt)}{n^2-1} \right)$$

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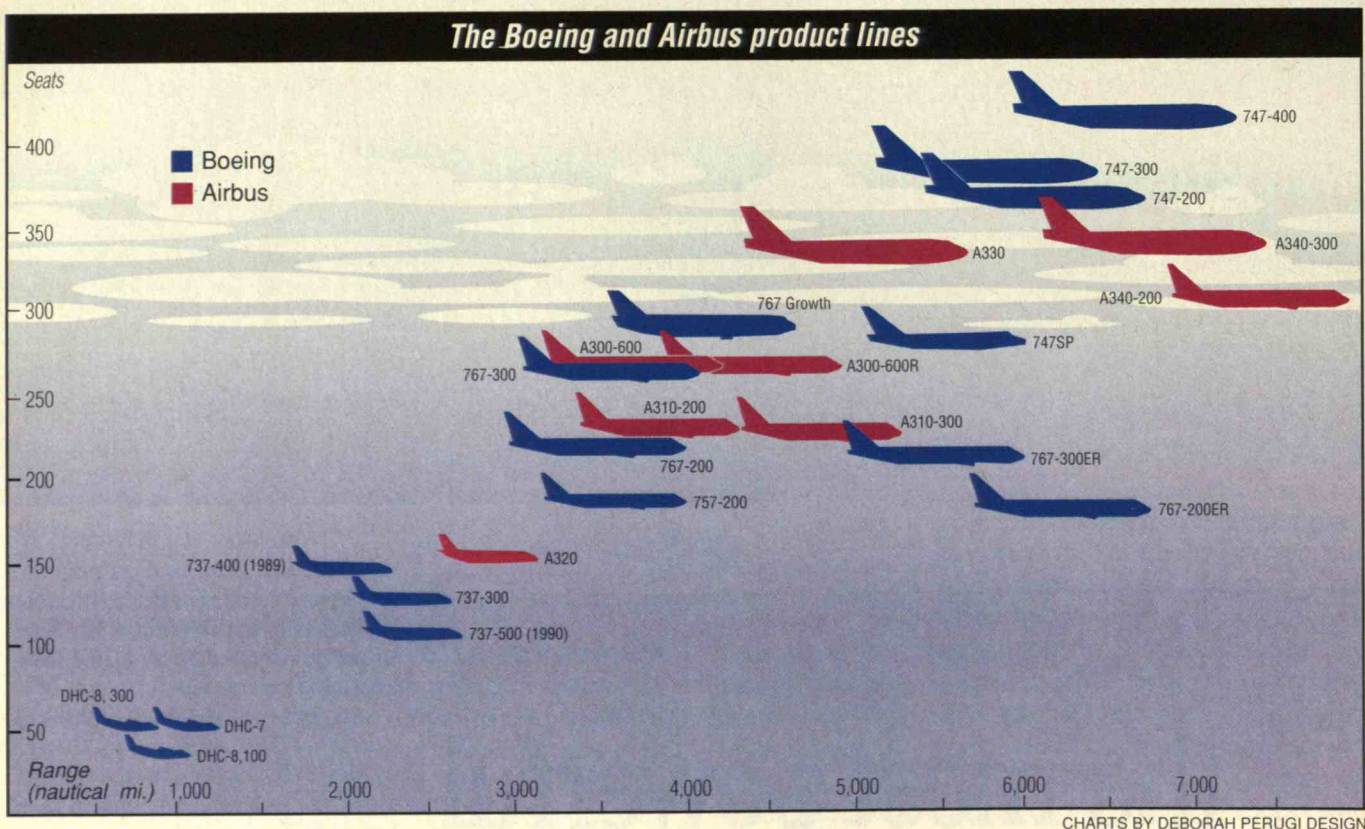
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Both Boeing and Airbus offer or plan to build a wide range of aircraft to fit diverse market niches.



with academics and officials in a number of government agencies, the AIA is attempting to forge a cohesive strategy, without asking for any additional government funds.

Nevertheless, federal action must complement industry reforms. Governments have always played a critical role in aviation, and foreign ones still do. In particular, Washington should heed the recent recommendations of the National Academy of Engineering and the National Research Council that NASA expand its mission in aeronautical R&D. NASA must be directed and funded to act upon its charter, which includes testing and proving new technology. This would extend its traditional commitment to basic and generic applied research. Moreover, NASA should aggressively monitor and distribute foreign aeronautical research to U.S. firms, while placing some limits, such as time delays, on releasing critical NASA research results to other nations.

Anti-trust laws must be modified to unambiguously allow domestic firms to cooperate in developing technology. Foreign competition both prevents the dangers of domestic monopolistic practices and requires U.S. companies to work together.

Furthermore, federal regulations—especially those regarding safety and the environment—can serve a vital market function. Airlines will retire their aging fleets as noise regulations are enforced, and strict implementation of these rules can speed the purchases of new aircraft and engines.

Finally, the U.S. aviation industry, like other industries, is in great need of a much more well-educated workforce. It especially needs manufacturing engineers who combine theoretical and practical knowledge. On the production level, effective apprenticeship programs and technical education would bring U.S. workers closer to the level of their European counterparts. Many European aviation workers, for example, receive a minimum three-year apprenticeship that teaches skills, responsibility, and accuracy.

Such programs require partnerships among companies, unions, and governments and draw on a philosophy of investing in people rather than treating them as an expense. They must grant workers greater responsibilities as well. And success depends on rebuilding firms from the bottom up. Only a radically reorganized culture will fully realize the potential of aircraft technology. ■

MIT

JANUARY 1990



The 50th anniversary of Aero & Astro is in some measure a celebration of the work of Jerome Hunsaker, SM '12.

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MIT

JANUARY 1990

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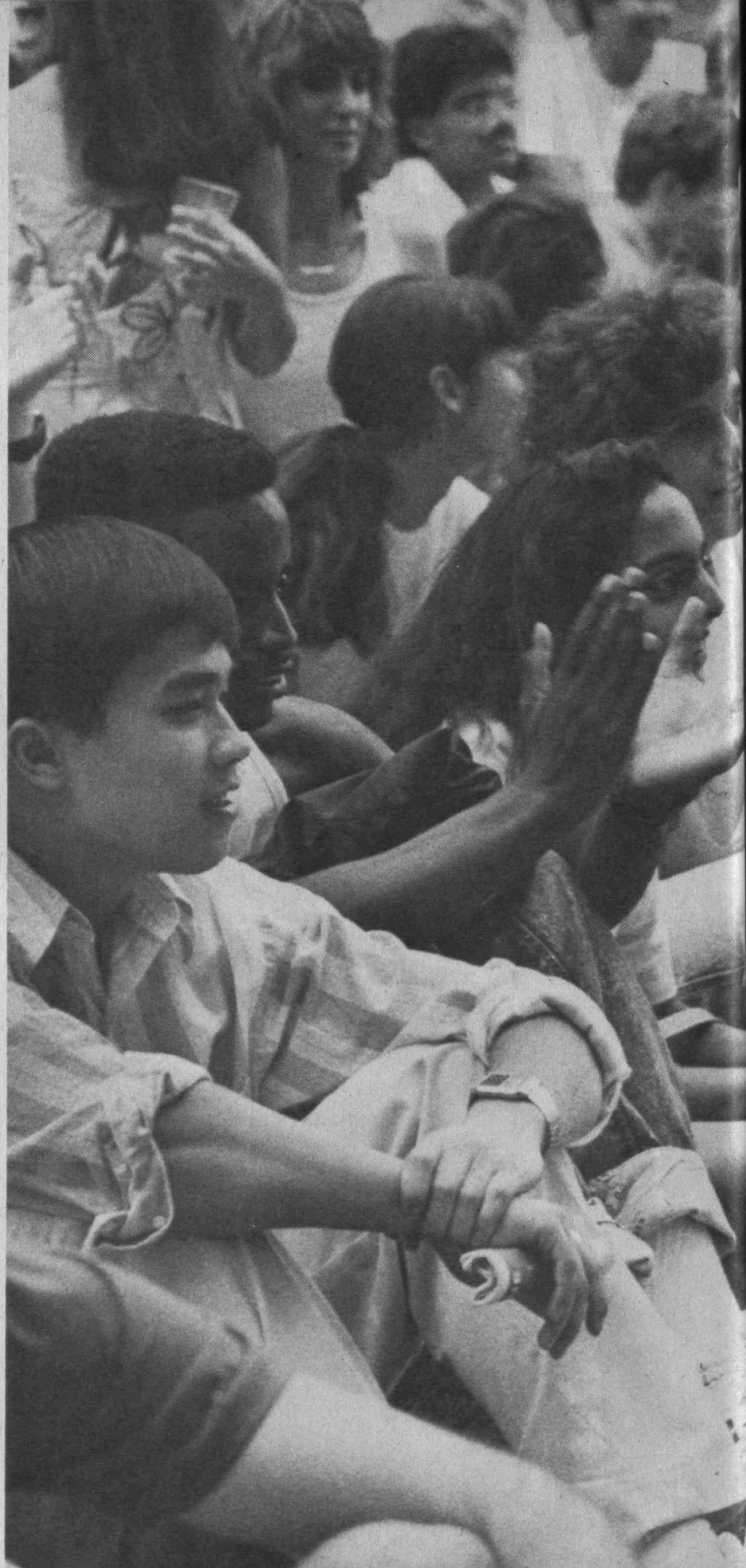
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COVER:

When we first saw this photograph of Jerome Hunsaker, SM '12, the giant of the early years of the Department of Aeronautics and Astronautics, we said, "Isn't this a heroic pose, like he's on the cover of Fortune magazine?" Good guess. Hunsaker's role as a pioneer of flight was widely recognized outside MIT as well as in, and this photo was used in an article in the November 1936 issue of Fortune.



The Verdict Is In On ADMISSIONS

*Once Again, There Are
No Easy Answers*

Given the daunting nature of admitting an undergraduate class, it isn't surprising that many MIT faculty members and alumni/ae are looking for a clean, simple approach. Think of it: in a highly competitive market, MIT must recruit more than 1,000 of the country's most outstanding high school students every year. These students must meet the rigorous standards of MIT faculty in fields as diverse as nuclear engineering and English literature. What's more, the composition of each class must serve objectives as unrelated as the national pursuit of equal opportunity and the local goal of balancing enrollment over all MIT's departments and schools.

The critical step in the process of constructing each freshman class is evaluating something like 7,000 admissions applications, each one a "folder" packed with high school transcripts, teachers' recommendations, standardized test scores, comments from educational counsellors, and personal statements and essays from applicants. Knowing only what is in the folders, and that most of the applicants will grow and change dramatically in the next four years, MIT must look at an army of 17-year-olds and decide who would stumble and fall and who would flourish in this demanding environment.

It would certainly make the whole process much easier if MIT stated that the only criterion for admission is "academic excellence." Since even that standard would still be a little slippery, it could also state that the definitive measure of academic excellence is a high score on the college board tests. Such an extreme approach probably does not enjoy wide support, and no one still believes that standardized tests measure anything like intelligence. Still, all you

have to do is mention that some students admitted to MIT had lower test scores than some applicants who were not admitted, and members of faculty and alumni want to know *why*.

In 1988, a study by Physics Professor Anthony French showed a drop in mean test scores over a 20-year period. When that information was combined with a pervasive sense among faculty that students are not as motivated or competent in mathematics and science as they were in recent memory, faculty concern about admissions came to a head. The fact that MIT had made unprecedented progress in recruiting women and underrepresented minority students over the same 20-year period only made the situation more delicate. That's where MIT was when the faculty Committee on Undergraduate Admissions and Financial Aid (CUAFA) began a study of admissions in the fall of 1988.

(At MIT, underrepresented minorities includes African-Americans, Hispanics, and Native Americans.)

After a heroic effort, CUAFA last spring issued a report universally acclaimed as thoughtful and "statesmanlike." The report affirmed that MIT's undergraduate admissions policies and procedures are working well. But it called for placing greater weight on "demonstrated capability in MIT's traditional strengths in mathematics and science. . . ." Furthermore, CUAFA concluded that although the admissions process is responsive to positions articulated by the faculty, there is no substitute for having faculty read admissions folders, help to evaluate those 7,000 exceptional individuals, and participate in decision-making.

So the ball is now in the faculty's court. Will they read the CUAFA report and participate in discussions of admis-



CUAFA paid particular attention

*to the question of how successful women and minority students
have been at MIT.*

sions issues? Will they support the committee's call for more studies of student performance and the admissions process, so that future discussions can be based more on information than conjecture? And will they respond to the efforts by CUAFA and the Admissions Office to involve many more of them directly in the admissions process, year in and year out?

The importance of the CUAFA report to the Institute is reflected in the fact that 1988-89 CUAFA Chairman Keith Stolzenbach, '66, associate professor of civil engineering, and Director of Admissions Michael Behnke made the major presentation at the Alumni/ae Leadership Conference (ALC) in October. Michael Behnke reported on the study and on the Class of '93 at the fall meeting of the Corporation Development Committee (CDC), and the report was on the agenda for both spring and fall meetings of the faculty.

One of the first things CUAFA did was to address the issues raised in the French Report by extending the analysis back to 1962. The committee found that "the test scores of the class entering in 1962 were very similar to those of current classes. From 1962 to 1968, the number of students in the highest range of scores increased dramatically . . . The

committee has speculated that this increase occurred . . . as a result of the national post-Sputnik emphasis on primary and secondary education in general and upon science and mathematics in particular." CUAFA cited an Admissions Office study that showed that the number of applicants with the highest scores have been a decreasing fraction of total applications, although the absolute numbers have remained substantial.

CUAFA focused on a number of key questions:

- How has MIT's admissions process evolved?
- Have there been significant changes in the interests and performance of MIT undergraduates? If so, are these the result of changes in admissions?
- What qualitative or quantitative information is actually useful in predicting and evaluating undergraduate success at MIT?
- How can the links between the faculty and the admissions process be strengthened?

To answer the questions, the committee cast its net as widely as possible. The members looked at every report or statistical summary they could lay their hands on that bears on undergraduate performance or the profiles of admitted students. Their report highlights the dif-

ficulty of the search for quantitative correlations between admissions criteria and later academic success at MIT. National studies show that admission indices correlate best with first-year grades, but MIT's pass/no record grading system for freshmen doesn't produce data for this kind of study. Comparing admissions indices with upperclass grades offers only broad correlations. "The committee notes particularly that admissions credentials are good predictors of success but poorer predictors of failure. A substantial number of students with low to medium level scholastic indices perform very creditably at MIT."

CUAFA found a particularly imaginative way to add to the usual measures of success—upperclass grades and graduation rates: it requested that each department provide a list of its "best" students, where best means "the kind of students you would like to see more of." The committee looked at the admissions profiles of those students, to see if they could identify predictors that these students would do unusually well. Here too, the "best" students exhibited a whole range of academic and personal ratings at the time of admission.

The most important activity of the committee, Stolzenbach believes, was talking to people. They met with past directors of admissions and chairmen of CUAFA, present admissions staff, the undergraduate officers in almost every department, and the teachers of freshman core subjects and other faculty who have had extensive experience teaching undergraduates. They solicited comments from faculty and circulated a preliminary report to which all faculty could react.

CUAFA also heard from the Undergraduate Education Office, the Office of Minority Education, the representatives of the Undergraduate Association, and the Student Committee on Educational Policy. They talked to the Office of Career Placement about the career choices of graduating students. There were weeks when the committee met three times, which is more than some classes.

In general, the report states, "about half the faculty have detected no troubling changes [in student academic performance] over the long or the short term. The other half was less positive and expressed varying degrees of concern."

Instructors in the core subjects in math and physics noted a decline in performance, and in several instances have found it necessary to adjust both the level and pace of the class, CUAFA found. Instructors in the two core chemistry subjects, on the other hand, re-

ported no downward trend.

In spite of its concerns in the core subjects, the Physics Department has seen no change in the quality of its majors, and the EECS faculty considered the 1988-89 crop of juniors majoring in computer science the "best ever." The departments in the School of Humanities and Social Science reported an increase in the number of their majors and in the quality of students enrolled in HASS subjects, to the extent that some HASS faculty describe their students as comparable to the best humanities students at other top universities.

Mathematics was the locus of much concern. For one thing, faculty teaching upperclass subjects in the School of Engineering frequently commented that students had trouble with basic skills in math. At another level, the Mathematics Department has discerned a decline in both the number and quality of its majors over a period of 20 years. One long-time math professor reported that the ability of his students, as indicated by exam performance, is undiminished; but he finds that student interest in mathematics is considerably less intense than it once was.

Members of the Mathematics Department were not the only faculty to observe a lessening in the intense focus on science and engineering that once characterized nearly all MIT undergraduates. Some faculty observe a greater orientation toward careers and less excitement about learning. And many areas of the Institute report that students have wider interests, both academic and extracurricular, than they once did.

At least in part, students with a wide range of interests are here by design, Michael Behnke said at the ALC. For many years, MIT has had outstanding faculty in the humanities, and it always had at least a few students whose ability in science and technology was accompanied by serious interests in the humanities and social sciences. These students often felt alienated from mainstream Institute culture. At the same time that these students were learning to become more expressive of their personal frustrations, the Institute leadership was becoming more and more convinced that single-focus technologists were not going to provide the leadership that this country needs to solve its most pressing problems. (See October 1987, page MIT 13, or November 1987, page MIT 4.) The president, the provost, and several of the deans spoke with increasing frequency of the need for more humanely educated engineers and scientists to address global issues.

The Admissions Office responded to these concerns by working not so much to increase the number of students ma-



A study of "best students"

*confirmed the value of using both numerical and personal ratings
in the admissions process.*

joring in HASS fields, but to create a critical mass of students with parallel interests in science and technology and humanities and social science. Admitting more diverse students has also been one step in the effort to curb by voluntary measures the over-enrollment in EECS in the 1980s. The policy seems to be very successful: faculty and students in HASS fields report being intellectually more comfortable within MIT, and in 1988-89 enrollment in EECS dropped low enough to permit the department to admit transfer students for the first time in many years.

There are other factors at work in the way students spend their time that are harder to identify. For example, the Office of the Dean of Students finds that students are more involved in volunteer work than at any time in MIT's history. Almost one-third of this year's freshman class indicated an interest in some type of community service.

In a nutshell, there seems to be no evidence of a shortage of students willing to work all night, just fewer students who work all night, every night, on one subject.

Faculty are anything but unanimous in their reaction to this shift in intellectual climate. But as CUAFA's open deliberations continued, it became clear that faculty are unanimous in requiring

competence in the math and science that defines an MIT education, and they think there should be a place here for at least some single-focus students of great intellectual promise. Before CUAFA released its report, everyone involved in admissions participated in a self-correction of the folder-reading process.

The freshman class that entered last September has slightly higher test scores, on both math and verbal, than the most recent classes. The percentage of students with the top test scores and grades increased substantially, and more students were admitted who had chosen to focus entirely on academics while in high school. The mean score on the Scholastic Aptitude Test math section rose from 722 for the Class of '92 to 735 for this year's incoming freshmen. Verbal scores on the SAT rose from 618 to 621.

Although the recent history of admissions at MIT has been distinguished by close cooperation between CUAFA—as the representative of faculty interests—and the professional admissions staff, the involvement of individual faculty has been small, and it has declined still further of late. The number of faculty reading folders, never more than about 50 out of a faculty of about 1,000 at the level of assistant pro-



Without any dramatic change in policy

or procedure, the admissions process was fine-tuned during '88-'89 to admit more students with the highest test scores and grades.

fessor or above, has recently been as low as 15. CUAFA's conversations with faculty "highlighted the faculty's lack of familiarity with admission policy and the complexities of its implementation and an accompanying feeling of alienation from a process they regard as vital to MIT."

In an effort to involve more faculty, CUAFA and the Admissions Office staged a mock "roundup," the final session at which decisions are made on whether to offer admission to applicants whose folders have been read and rated earlier. The session was a two-way street: faculty had an opportunity to learn first-hand about the aforesaid complexities, and the admissions staff was able to learn first-hand about the views of faculty.

Faculty and administrative staff of the Institute are all invited to participate in reading folders, and each folder is read by at least one professional from the Admissions Office. Heretofore, there was a requirement that only those faculty and staff who had read a minimum of 50 folders were eligible to participate in roundup. To further facilitate faculty involvement, the minimum was dropped to 30 folders. An objective for the future, Stolzenbach told the ALC, is not only to increase the number of faculty reading folders and participating in roundup,

but to ensure that the representation of faculty from all schools and departments is more balanced.

For at least 45 years, applicants to MIT have been ranked on both numerical (based on standardized tests, grades, class rank) and non-numerical (teacher recommendations, interviews, prizes, extra-curricular activities) evidence. In 1986, for a variety of reasons, CUAFA and the Admissions Office restructured the rating system to create a new Numerical Index (NI) and a three-part personal rating (R1, R2, and R3). The NI is an arithmetic average of the quintile ranks of an applicant's grades (including humanities subjects), test scores, and class rank weighted to allow for the competitiveness of each high school. R1 is a rating of the applicant's intellectual promise beyond that indicated by grades and scores. (Examples of non-numerical evidence of intellectual promise include participation in science fairs or winning prizes in science or mathematics.) R2 is a rating of personal qualities such as motivation, energy, and leadership. R3 rates extra-curricular accomplishments. The value of using both personal and academic ratings was confirmed by CUAFA's "best student" study.

These ratings are fairly sophisticated

tools to help ensure consistent, fair treatment across the huge applicant pool. But CUAFA discovered that the character of an entering class is determined not so much by the definition of numerical and non-numerical ratings as by the relative weight put on these factors at the time the admissions decisions are made. Furthermore, the committee found that this weighting had apparently changed significantly over the previous 20-year-period. "Since the early 1970s (the first years in which data on individual students are available), MIT has admitted a smaller percentage of the applicants with the very highest scores and grades," CUAFA reported.

The change in the test score profile of MIT freshman classes is to some extent a response to the Institute's effort to encourage a better balance between the numbers of men and women students. National studies have shown, Behnke reports, that standardized test scores underpredict the academic performance of women. MIT admits women students with lower mean test scores than men, and the records show that by sophomore year, the grades of women students are as high as those of men.

As Behnke reported to the CDC, the increase in the numbers of women (from 5 to 33 percent of each entering class) and underrepresented minorities (from 1 to 15 percent) is the most dramatic change in admissions at MIT over the past 20 years. While on the one hand that change in the makeup of an MIT class has been celebrated as an achievement, it was certainly cause for concern when the same 20-year period seemed to see some academic decline.

CUAFA deserves a lot of credit for facing head-on the sensitive issues inherent in that situation, to wit: "CUAFA paid particular attention to the question of how successful women and minority students have been at MIT, and whether the presence of larger numbers of women and underrepresented minority students has contributed significantly to the concerns and discontent that motivated this policy review."

They found that the algorithms used in computing the numerical indices are uniform for all applicants, but that standards for applying those indices are not the same. Women, as mentioned, are admitted with slightly lower test scores on math and science than men, and "the criterion for underrepresented minorities is that in the judgment of the Admissions Office, assisted by the Office of the Dean of Student Affairs, the applicant will be able to succeed academically at MIT."

Behnke explained that the admissions

staff looks for unusually high motivation, determination, and perseverance in the case of minority students—indications that they have achieved as much as possible within the limitations of their environments. He told the CDC that the minority students in the Class of '93 are the most academically qualified members of their cohort at any university in the country. That doesn't mean their careers at MIT are clear sailing, however.

The grades of women, over four years, are statistically indistinguishable from those of men, and their seven-year graduation rate averages 2 to 3 percent higher than that of the total population. Minority students and non-minority students admitted with similar numerical indices achieved comparable grades and graduation rates. But many minority students admitted with lower numerical indices also have grade-point averages lower than those of non-minority students.

For years, MIT has accepted responsibility for helping minority students with weaker backgrounds to bridge the gap between themselves and their peers. But CUAFA notes that "while the enrollment of minority students has increased over the last several years, the scale of support activities (the pre-freshman Interphase program and the Office of Minority Education) has not expanded at anywhere near the same rate." It went on to state that "the committee is worried about the match between expectations and resources in this regard." The administration has already begun to respond to that concern with the new Program XL, a first-semester freshman support program for minority students and others who believe that they need extra academic help.

All those faculty who communicated with CUAFA on the subject of MIT's affirmative-action program and recruitment of women support those programs. "The faculty's concern, where expressed, arose from perceived changes in the student attitudes and motivation in the general population and not in any particular segment."

CUAFA was quite clear in its recommendations. "The committee is convinced that admissions decisions should place greater weight on demonstrated capability in MIT's traditional strengths of mathematics and science, and in particular on a strong commitment to these disciplines." They went on to assert that "the implicit weighting in recent admissions decisions does not reflect the views of a sufficient number of faculty with regard to what constitutes an excellent applicant for MIT."

It recommended no changes in the ad-



The faculty's concern arose from perceived changes in the attitudes and motivation of the general student population, not those of any particular segment.

missions procedures for women and underrepresented minorities except for the caveat that "the number of students for whom admission to MIT might entail some risk should be consistent with the resources available and the institutional commitment to these students."

Importantly, CUAFA recommended that the undergraduate committee of each department be asked to provide at least one faculty member to read admissions folders, and that these faculty members be encouraged to read enough folders to acquire a sense of the range of applicants and be encouraged to participate in admissions decisions. In an innovative move, the committee called for this group of readers to meet with CUAFA and the Admissions Office staff each year after roundup to review the admissions process. "This [step] will help capture some of the experience now acquired and lost. At the same time, the departmental representatives will provide a natural path for communications between the Admissions Office and the faculty."

The report suggested a whole range of links between faculty and the admissions process, and between Admissions Office staff and the academic enterprise at MIT, links that the committee notes would be particularly important for new faculty and staff.

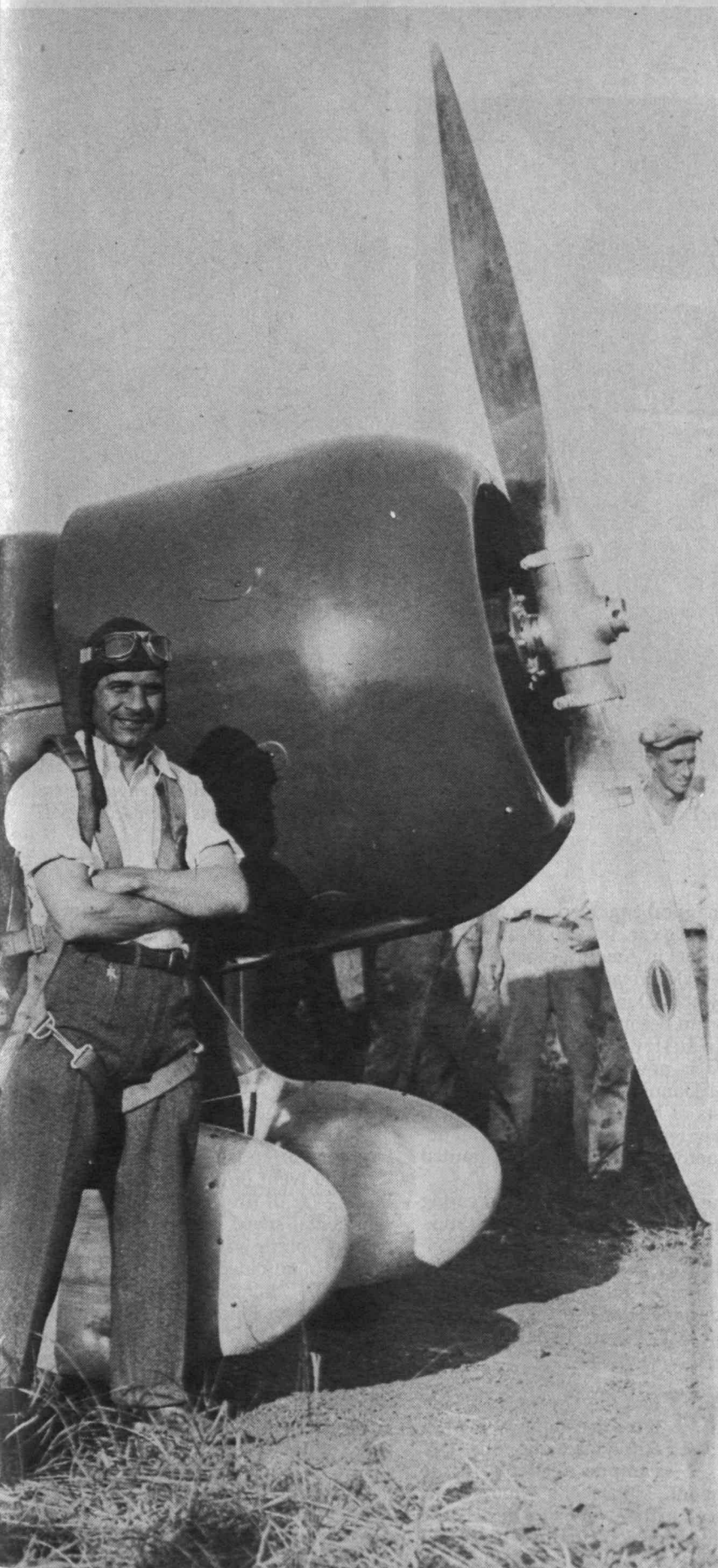
And finally, the committee reported a "lack of coordinated and focused study of the undergraduate academic experience," and urged that "there be institutional encouragement and support for coordinated educational studies."

Low-key and thoughtful as CUAFA's recommendations are, they are not unproblematic. More faculty involvement, in the form of reading folders and attending various meetings, takes time, which is already in very short supply at MIT. More support services for students at risk and studies of student performance involve a serious commitment of resources, particularly difficult to come by when the Institute is grappling with a budget deficit (see April 1989, page MIT 9). It's important that members of the Institute community not focus merely on the recommendation that more emphasis be given to achievement in and commitment to math and science, and thus consider the admissions problem "solved." CUAFA couldn't have been more direct in saying that that won't be enough. □

Copies of the full CUAFA report, with numerous charts and statistical summaries, is available from William J. Hecht, '61, executive vice-president of the Association of MIT Alumni and Alumnae, Room 10-110.

"AP, AUGUST 22, 1931 - Jimmy Doolittle, [ScD '25], famous speed flier who 'definitely retired' from stunt flying several months ago after a narrow escape from death, has had a change of heart. He announced today that he will fly a powerful biplane, said to be capable of making 300 miles per hour, in the national air races in Cleveland. Doolittle is shown outside the ship after a test flight at Ashburn Field, Chicago."





AERO & ASTRO STILL FLYING

After All These Years

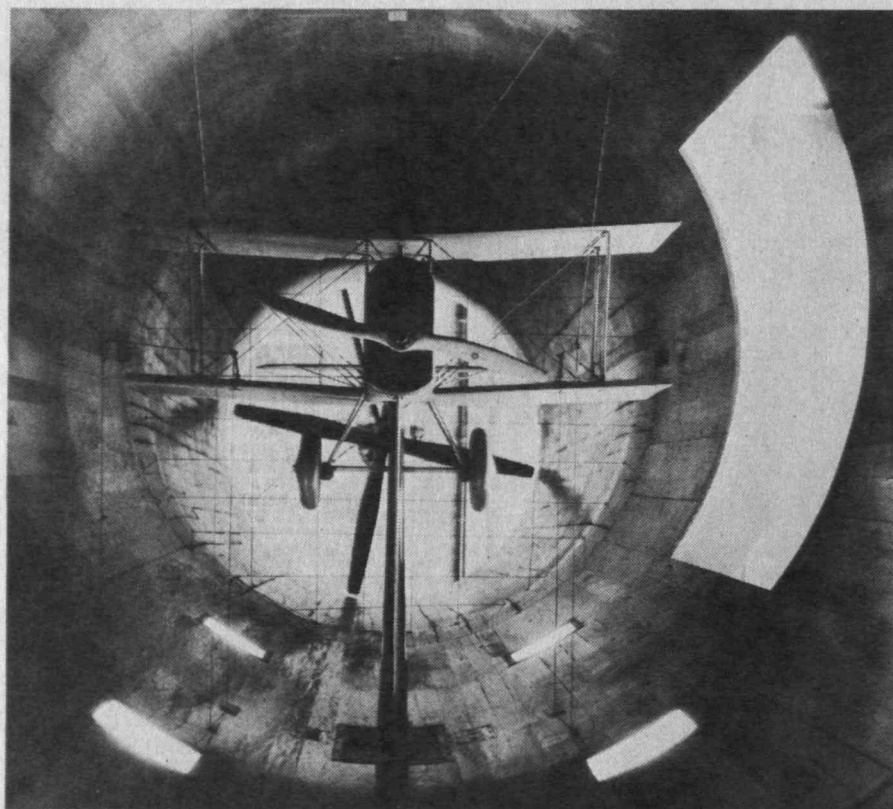
The flight path of MIT's Course 16, since its rise as a graduate aeronautics program in 1914, has resembled a bit more that of a barnstorming puddle jumper than of an Atlas-Centaur rocket. Taking off under the aegis of the Department of Naval Architecture, Aeronautics came under the wing of the Physics Department in 1920, and became an independent division in 1926. After coming under the administrative auspices of the Department of Mechanical Engineering in 1933, Aeronautical Engineering finally flew free as a department in 1939, with Astronautics joining the formation in 1960.

So the decision of *when* to hold a 50th anniversary of *what* regarding Aero & Astro was by necessity a rather arbitrary one. "I have not been able to find anything that happened as a result of changing from Course 16 to a department in 1939," Professor Emeritus Walter McKay, '34, told the more than 300 people who attended the 50th anniversary on September 15-16, 1989. "Did anything really happen? Or was it a non-event?"

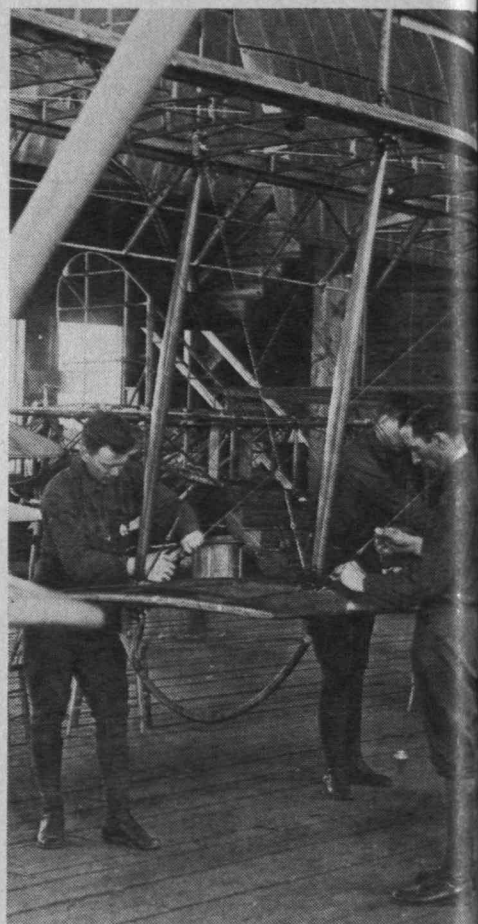
But no one in the audience seemed to worry whether the 50th anniversary had any special significance, *per se*. What they were really celebrating was the crucial role Aero & Astro played in building up the nation's aircraft industry—both for commercial and military aviation. The early fall weekend provided a time to reflect on the department's proud history of accomplishments, as well as to look at the future of the field and MIT's role therein.

Aeronautics research on campus began in 1896, when a senior, Albert Wells, designed and built a small wind tunnel—possibly the first such tunnel in the United States—drawing on air currents from the Institute's ventilation sys-

BY STEVE NADIS



A one-eighth model in MIT's second wind tunnel, built in 1921.



U.S. military engineers and pilots descended on MIT

tem. Several students used the tunnel for experiments on glider and propeller design. There was limited interest in aeronautics, however, until students founded the MIT Aero Club in 1909. Members of the club designed and built two gliders, one of which won a prize in a glider competition the next year.

In 1913, MIT President Richard MacLaurin decided to establish an aeronautics program. He chose Jerome Hunsaker, SM '12, to develop courses on the subject. Hunsaker's degree was in naval architecture, but he had since become more interested in airplanes than in ship construction. He went to Europe to study the state-of-the-art in aeronautics, spending part of his time in the laboratory of Alexandre Gustave Eiffel. Hunsaker translated into English Eiffel's classic treatise on aerodynamics, which included the principles employed in the construction of his famous tower.

In 1914, Hunsaker returned to MIT and created the first graduate program

in aeronautical engineering in the country. In that year, he also built the first wind tunnel in America capable of testing full-scale aircraft. He was assisted in the project by Donald Douglas, '14, who went on to become a leader in the aircraft industry. (The company he founded is now part of the aerospace giant McDonnell Douglas.) In 1916, on the basis of his wind tunnel research, Hunsaker received the first doctoral degree in aeronautical engineering granted by MIT.

As the United States began preparing for World War I, Hunsaker was summoned by the Navy to oversee the construction of the Navy's blimp and airplane force. In 1919, the NC-4—a plane designed by Hunsaker and two others at MIT—became the first airplane to cross the Atlantic.

When the United States entered the war in 1917, MacLaurin made the entire MIT campus available to the government. Hunsaker's wind tunnel was leased to the Army, and most of the aeronautics officers in the Army and Navy were trained at the Institute. In

all, more than 6,000 military engineers and pilots learned about aircraft maintenance and navigation at MIT ground schools. Among the naval officers sent here was Leroy Grumman, father of the Grumman Corp.

In 1920, aeronautical engineering was moved to the Physics Department and placed under the direction of Edward Warner. Among the famous graduates of this period were Charles Stark Draper, '26, and James Doolittle, ScD '25, who went on to become a hero of World War II. (In addition to his transcontinental speed records and war exploits, Doolittle was the first pilot to land a plane blindfolded.)

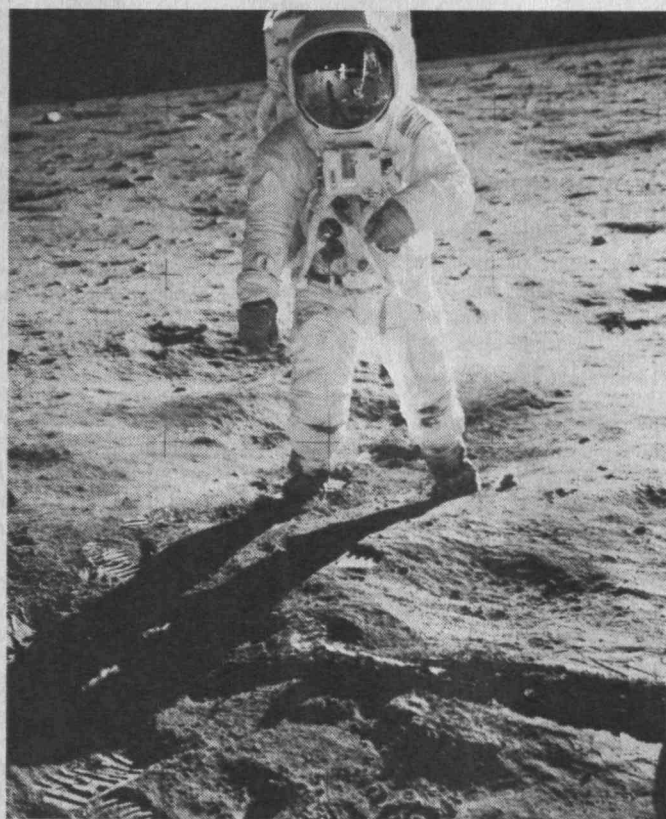
In 1927, "things began to happen," said Professor Emeritus C. Fayette Taylor, '29, speaking at the anniversary. "Lindbergh flew to Paris, and the next fall half the sophomore class [tried to] register for Course 16." Enrollment, however, was limited to 30 undergraduate students.

Hunsaker had retired from the Navy in 1920, taking a job with the Goodyear-Zeppelin Corp. He designed the *Shenandoah*, America's first dirigible, which had its maiden flight in 1923. Two years

STEVE NADIS frequently writes for Technology Review. Research and writing by Mark Vargas, assistant MIT archivist, contributed to this article.



by the thousands for aviation training in World War I.



Buzz Aldrin, ScD '63, engaging in some "extravehicular lunar activity." (6-20-69)

later, it was destroyed in a tornado. Two other blimps he built at Goodyear—the *Akron* and the *Macon*—met with similarly violent ends, cooling both Hunsaker's and the Navy's interest in lighter-than-air ships.

In 1933 Hunsaker returned to MIT to head the Department of Mechanical Engineering and Course 16. He presided over the creation of the Department of Aeronautical Engineering as an independent entity in 1939 and served as its chairman until his retirement in 1951.

Draper was next at the department's helm. He was originally hired in 1935, receiving an ScD in physics a few years later in 1938. By then, legend has it, he had taken more courses for credit than anyone else in MIT's history.

Draper took what at the time was considered an innovative approach to education but now is a hallmark of MIT: he believed that working on "real world" problems was the best way for students to learn scientific thinking, engineering design, and technological implementation. To provide graduate students with experience in aircraft guidance and control systems, he established a small instruments lab in 1935,

which later grew into the Instrumentation Lab. One of Draper's inventions, called the Shoebox, served as a model for the gyroscopic Mark 14 Gunsight, widely used by U.S. forces in WW II.

During the 1950s, the Instrumentation Lab had a staff of 1,000, and most of the work took place in a converted shoe-polish factory on Albany Street. By the following decade, astronautics was an official part of the department, and the Lab developed the guidance and navigation (G&N) systems for the Apollo flights to the moon. (Incidentally, Buzz Aldrin, ScD '63, as the second man to walk on the moon, personally made use of that technology. His father, Edwin E. Aldrin, Sr., received a master's degree in aeronautics in 1917 and a doctorate in 1928.) The Lab also designed the G&N systems for the three Skylab missions and the Apollo-Soyuz space rendezvous in 1975. By that time, the Lab had become an autonomous company, Draper Laboratory, having separated from MIT in 1973.

In the aftermath of the radical '60s, things were tough for Aero & Astro, according to Professor Rene Miller, head of the department from 1968 to 1978.

The year he took over, there were only 12 graduating majors—a low ebb that reflected the prevalent "anti-technology" trend. "We were on the verge of being absorbed by Mechanical Engineering—a fate worse than death—so we really buckled down," Miller said. The labs opened their doors to undergraduates through the UROP program, and enrollment slowly started to climb. "I'd like to think it was due to our programs, but perhaps it was due to the rise in the aerospace industries," he observed.

In contemplating the future of aeronautics, Draper Laboratory Vice-President Donald Fraser, '62, who spoke at the anniversary celebration, underlined the difficulties of making accurate predictions. As an example, he cited a statement made by IBM head Thomas Watson in 1958: "I think there will be a market worldwide for about five computers."

These uncertainties notwithstanding, current Department Head Eugene Covert, ScD '58, believes there will be "enormous opportunities" in the aerospace field in the next decade. The reason, he

says, is that many people who entered the field around World War II are now approaching retirement. "I wish I were 18 again," Covert said.

Jack Kerrebrock, acting dean of engineering and former head of the department, is also optimistic, in part owing to the emergence of a new "space generation"—people who have grown up in the space age and assume, as a matter of course, that they'll be working on space issues. As an example, he cited Aero & Astro graduate student Peter Diamandis, '83, one of the co-founders of the International Space University.

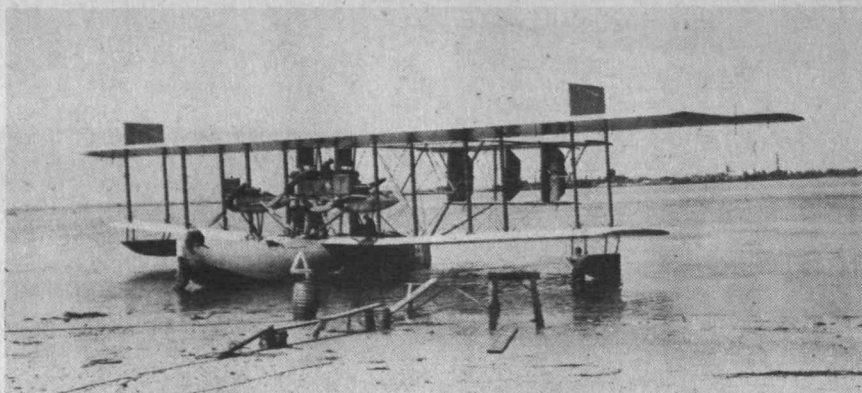
Another positive factor, according to Kerrebrock, is the "sense of community" permeating the field. "We're all space enthusiasts," he said. Other professions, he contended, don't necessarily share such intense excitement about a particular set of goals.

However, Kerrebrock did issue a warning. "I don't think we've always done as good a job as we can," he said. A classic case was the supersonic transport (SST). "We did a fine job designing the plane," he acknowledged. "But it was others, not aeronautical engineers, who did the thinking about environmental aspects. In the future, we should take the initiative on such matters, rather than just respond to criticism."

This brings up the question of how to train the new "space generation"—a matter which received considerable attention during the anniversary discussions. "The practice of engineering is becoming increasingly complex," explained Fred Jischke, PhD '68, chancellor of the University of Missouri. "Engineers not only have to deal with issues as they come up, but they also have to anticipate new issues."

The challenges facing educators in the aero and astro field are representative of engineering education in general—an explosion of technical advances, increased responsibilities for engineers, the need for greater organizational skills and a "systems" approach to complex tasks, familiarity with business, fluency in foreign languages, and, as some have called for, broader training in the humanities.

"There is merit to all these ideas," said Robert Loewy, '48, of Rensselaer Poly-



The first plane to cross the North Atlantic—the Navy's NC-4 designed by Jerome Hunsaker, SM'12—left Newfoundland on May 16, 1919 and arrived in Lisbon eleven days later.

technic Institute, who chaired the panel on education. "But students have limited time, and it's all accounted for."

The problem is not new. Draper referred to it years ago as "the incompressibility of time." But what can be done about it?

"Doggone it, we can't just talk faster," said Holt Ashley, ScD '51, a faculty member at Stanford. "It drives the students crazy." One potential answer, according to Ashley, would be the creation of a new, two-year graduate engineering degree, respected in its own right and not considered a "consolation prize" for those not admitted to doctoral programs. At the moment, he said, perhaps the main obstacle to the program is that "we need a catchy name for it."

Education, of course, is not only a concern for college students. How do practicing engineers, some of whom received degrees decades ago, keep up with the pace of new developments? "Engineers have to view education as a lifelong process," Kerrebrock said. "There's no end to it."

Draper had his own views on training professional people in technology, claiming it can be effective only "if it is carried out, not by teaching, not by professors controlling situations and making artificial problems, but by experience within a real working environment."

A shining example of this approach was the *Daedalus* project in human-powered flight in 1988. Another, highlighted at the anniversary dinner, was the EASE (Experimental Assembly of Structures in Extravehicular activity) program directed by Professor David Akin, '74. The project demonstrated how space structures can be built in space, and it involved 47 people from MIT, almost all of whom were undergraduate or graduate students. EASE hardware flew on the space shuttle *Atlantis*, which was launched in November 1985. In the course of the mission, astronauts assem-

bled and disassembled a space structure nine times during spacewalks.

The EASE experiments—as well as ACCESS, a similar project undertaken by NASA's Langley Research Center that flew on the same shuttle—represented the first structures ever assembled in space.

"It was the first time that astronauts had gone outside to do an experiment, as opposed to [just performing] operational requirements," Akin said. "And it was the only time that a primary mission payload was totally designed and built by students."

Neil Hutchinson, Director of NASA's Space Station Office, was impressed by the success of EASE and ACCESS. "A week ago, we were trying to figure out how to design the space station structure," Hutchinson commented shortly after the mission. "Thanks to your experiments, we can design the space station to be manually erected."

Akin and his students are now designing robots that can build the space station as well as service the Hubble Space Telescope. To simulate zero-gravity conditions, the devices are being tested in the neutral buoyancy tank at the NASA Marshall Space Center in Huntsville, Ala.

Work in Akin's lab is a prime example of "systems engineering," a buzzword heard frequently at the anniversary symposium. Students learn to work in teams, while designing systems that have immediate applications in the outside world. "It's not idle academic research," Akin says. "They know that NASA is looking closely at their work, as if we were an actual NASA research center."

The work has attracted top-notch students who, upon graduating, are generally well-prepared for the kind of work they'll find in the aerospace industry. "I've gotten nothing but raves from people who've hired my graduates," Akin says.

Projects like EASE and Akin's more recent robotic work offer models that address some of the concerns of educators who are trying to balance competing demands within their profession. Ironically, this work is coming to an end. Akin did not receive tenure and will be leaving MIT at the end of this academic term. □



CLASS NOTES

15 75th Reunion

Please send news to your class secretary.—**Joyce Brado**, acting secretary, 491 Davison Rd., #9, Lockport, NY 14094

16

We regret to report the death of **Daniel Comiskey** on August 11, 1989. Dan and his wife, Grace, who predeceased him, were regular attendees at our reunions. Dan was with us at our 70th reunion. Dan was in the milk business in the Greater Boston area most of his life. He was a joy to be with, and we'll miss him. May he rest in peace.—**Bob O'Brien**, acting secretary, 25 Keith Rd., Pocasset, MA 02559

17

The Alumni Association has forwarded a couple of fine letters received this summer from **Osgood W. Holt**. Having seen no recent news about classmates, he wondered if he alone now represented the class of 1917. No. There are about 20, plus several widows, but not many of you can communicate with us—and your acting secretary, being 1 year old when your class graduated, is not really qualified to reminisce on your behalf without a little help. So do write.

Osgood is 94. This spring he was honored by election into the Republican Inner Circle Club as a result of organizing the first Republican Club in Aiken County during his last year of work at the Savannah River Plant. Not only did Aiken County and City turn Republican for the first time, so did South Carolina. Also, the senior senator from South Carolina changed that year from Democrat to Republican and has remained so for nearly 30 years.

Osgood was fortunate to have been married only once—for 63 years—and is blessed with our great-grandchildren, the oldest now in college. But as with many classmates, he expects he will have to live in a nursing home from now on. His latest address is 124 Walnut, Apt. #1, Woodland, CA 95695.

We have also received the sad news of the death of **Walter Lyon** at age 98. A teacher for 45 years, 25 of them in the Boston area, he retired to New Hampshire in 1963. Since 1970 his home was in Nashua.—**Don Severance**, '38, acting secretary, 39 Hampshire Rd., Wellesley Hills, MA 02181

18

Your secretary attended the MIT Alumni Leadership Conference at MIT September 23, 1989. It was good to see so many active and enthusiastic alumni gathered for an all-day session devoted to learning about exciting new developments in many areas. In particular, I was impressed with what is happening with the freshman class—how

are encouraged to participate in so many activities in order to know better their classmates and their teachers. The faculty agreed in principle to add biology to the three fundamental studies—calculus, chemistry, and physics—that all undergraduates must study. It is a dramatic improvement in preparing today's freshmen to meet the challenge of today's world when compared to my freshman days some 75 years ago.

I record with sorrow the death of **Leonard Levine** in early September 1989. He was a very active and devoted member of our class and went the extra mile to make our reunions successful. We are indebted to his wife, Gladys, for this summary of his career: "Leonard was a class officer at MIT. After graduation, he was a professional engineer with the Army Laboratories, where he distinguished himself in a cost-reducing program under President Johnson, receiving money and honorary awards for his efforts. He was retired at 65, reluctantly, and in two weeks was placed as an instructor at Northeastern School of Technology, where he taught for 10 years and retired for the second time. From there, he gave five years of voluntary instruction at Brookline High, including an hour or more a day reading to a blind gentleman 100 years of age."—**Max Seltzer**, secretary, 865 Central Ave., Needham, MA 02192

19

During the last two years, I have made several attempts to reach **Leo A. Kelley** of our class but without success. A few days ago he called me from Corpus Christi, Tex. He is now 92 years old and doing quite well. He would like to hear from classmates and mentioned **Don Way** and **Timothy Shea**. I am sure he would like to hear from you. See your recent copy of class addresses.

The Alumni Office has advised us of the death of **Robert Insley**, who lived in Detroit. Insley had a lifelong career in aeronautical engineering and was an active member of our class. We shall miss him. We express our pleasure in knowing him and working with him.

I would like to hear from you, so I can pass on your comments to our classmates.—**W. O. Langille**, secretary, P. O. Box 144, Gladstone, NJ 07934, (201) 234-0690

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70th Reunion

Please send news to your class secretary.—**Harold Bugbee**, secretary, 313 Country Club Heights, Woburn, MA 01890

21

According to a list from the Alumni Association, we have 88 living classmates, including two women. Both women, **Dorothy Pierce** of Utica, N.Y., and **Elizabeth T. Shepard** of Putnam, Conn., took Course 7, biology.

We received notices of three deaths this month: **Ernest R. Gordon** of Denver, Colo., on March 23, 1989; **Frank H. Coldwell** of Port Edwards, Wisc., on June 5, 1989; and **Joseph C. Moosbrugger** of Rockville Centre, N.Y., on June 20, 1989. Coldwell served in the U.S. Navy in World War I. He was employed by Bucyrus Erie Corp. before joining Nekoosa Edwards Paper Co. in 1925. He held various positions with the paper company before becoming manager of the combined engineering and power departments. He is the author of a number of articles published in technical magazines in connection with power and paper mill developments, stream pollution, and environmental improvement. He was active in civic affairs. . . . Moosbrugger was a graduate of St. Mary's College in addition to MIT. He headed Suburban Engineering Co. of Mineola, N.Y., which specialized in pool installations, water filtration, pollution control, and sewage treatment for municipalities.—**Sumner Hayward**, secretary, Wellspring House E64, Washington Ave. Ext., Albany, NY 12203; **Samuel E. Lunden**, assistant secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22

A kind note from **Bertha S.W. Dodge** humorously commented on the alumni register problem mentioned in the October notes. She has a like difficulty at Radcliffe while trying unsuccessfully to "shed the onus" of being the sister of Norbert Wiener. During the past year, a couple of books have been added to her credit—*Vermont by Choice* on early Vermonters, of which her late husband was one, and a translation into Japanese of one of her earlier books published by McGraw Hill.

William Hudson Lang, age 89, Course VI, died May 27, 1989, in St. Paul, Minn. For many years, until retirement, he was president of Foley Bros., Inc. of St. Paul. At MIT he was a member of Sigma Alpha Epsilon. I note in the 1923 *Technique* that there were 16 members of this fraternity in our class. Now the only SAE survivors are our class president, **Parke Appel**, and **Van Dorn C. Smith**. Lang is survived by a son, Professor A. Scheffer Lang, '49.

Howard Backus Sloan, age 91, Course X, a retired engineer for Sylvania Corp. in Salem, Mass., died June 28, 1989, in Cape Elizabeth, Maine. He is survived by his wife, Eleanor B. (Williams) Sloan. Our condolences are extended to the families of these deceased classmates.—**Yardley Chittick**, secretary, Rte. 1, Box 390, Ossipee, NH 03864

23

The October *Review* mentions a possible class reunion this coming winter, probably during the latter part of March 1990. A follow-up letter including a brochure was sent asking a reply. It is hoped that a good number will reply favorably. We will keep the membership of the class in-

formed as we proceed.

Our president thinks it might be of general interest for class members to share some anecdotes of their student days. In that vein, he forwarded several of his. . . . He remembers vividly a Mexican brother in his fraternity running around in a car with no top and no glass in the windshield frame. In a return ride from a trip to Royal's home in Lowell, the engine stopped dead in the center of Harvard Square. The fraternity had a strict rule about bringing hard liquor into the house. This same brother was found inebriated outside of the house one night and was carried into the house. A bottle was found on his person. He was to be punished but objected and won on the basis that he didn't carry the bottle in; the brothers carried it in.

Dave Joy and his wife, Muriel, who live in Florida, visited your secretary and his wife, Winnie, a short time ago after a boat trip from Connecticut to the St. Lawrence River. This has been an annual visit for some years. We went out to lunch and talked about the last reunion. You may remember that they could not attend because Muriel had broken a bone in her knee.

Word has been received of the death of Colonel **Philip E. Schwartz** on June 15, 1989. He studied mechanical engineering at MIT and attended Columbia University, Princeton University, and UCLA, receiving his BS and MA at the latter university. He was interested in education and later received a Ph.D. Interested in education, he interviewed many potential students for MIT. He was married and had three children and 13 grandchildren. Philip, a colonel in the U.S. Air Force, served in the Office of the Air Inspector, Pentagon, Washington, D.C. He received the Distinguished Service Medal and Legion of Merit, U.S.; CBE, Great Britain; Legion of Honor,

France; and Croix de Guerre, Belgium. He was vice-president and secretary of the MIT club of Southern California and class representative and area chairman for MIT. Certainly a busy man.

Harold Francis Crotty died June 10, 1989. He obtained his SB and MS in electrical engineering cooperation from MIT and an LLB from Boston College Law School. He and his wife, Catherine, had four children and two grandchildren. He was an electrical engineer and consultant for General Electric Co., having worked at plants in Schenectady, N.Y., and West Lynn, Mass. He was a life member of the American Institute of Electrical Engineering and also GEEA.

Myrna S. Howe died on April 23, 1986. Information is scant as there is apparently no next of kin. She was an educator and public health official. She served two years in World War I in France, 14 months in the U.S. Army hospital. In World War II, she served with the U.S. Army in Germany and at home. She also served with the Army in Peking, China, for one year during the so-called peace terms. She travelled extensively in many countries.—**Frederick O.A. Almquist**, secretary/treasurer, 63 Wells Farm Dr., Wethersfield, CT 06109

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Please send news to your class secretary.—**Mrs. Rockwell Hereford**, co-secretary, P.O. Box 5397, Carmel, CA 93921

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Mailing addresses of classmates need to be updated by your secretary from time to time. This

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task has been undertaken recently using an up-to-date list of addresses supplied by the Alumni Association. As of September 1, 1989, we have addresses for 161 classmates. A number of you have supplied Cambridge with address changes but several years have past since these changes have made their way to Chatham. Why not inform the secretary as well as alumni headquarters? Incidentally, it is no exaggeration when I say that more than half of the classmates included in the above 161 have been silent over the last 15 years. We would all like to hear from you. A few more figures—there are 94 classmates for whom we have no addresses. Of this group nearly half received their bachelor's degrees in 1925. Cambridge has supplied me with addresses for 74 widows of classmates.

Belatedly word has reached us that **Louis Small** passed away on October 22, 1987, in Passaic, N.J.—**F. Leroy "Doc" Foster**, secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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We have just returned from Martha's Vineyard off Cape Cod. Those of you who have never been there are missing a beautiful place. We visited at the summer home of my brother Mark, '32. My family also has had a summer home there for 70 years.

Barron P. Lambert of Baltimore, Md., died June 28, 1984. He leaves his wife. He was vice-president and trust officer at the Baltimore National Bank. . . . Lt. Col. **Robert W. Rogers** of Barrington, R.I., died last June 4, leaving his wife Rosamond. Upon graduation, Robert received a commission in the Army, and was very active



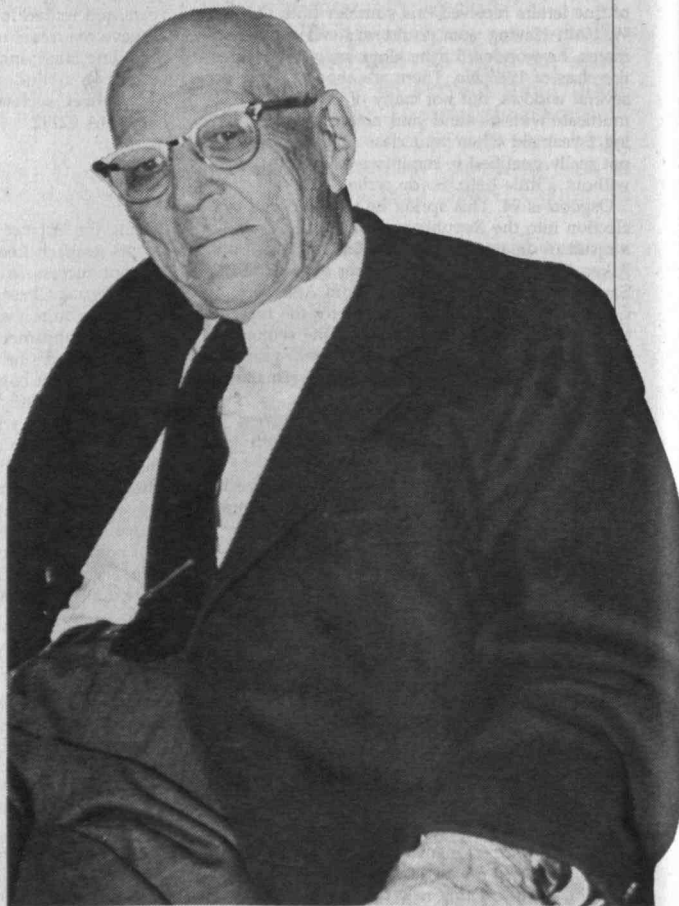
Happy 100th!

Rare is the birthday card with this inscription and rare the people deserving of it. But we have another in our midst—Thomas J. Lough, '13, who turned 100 last June 20.

Lough worked as a civil engineer before moving to Michigan in 1927 to become general manager of Thomas H. Stephens, Inc., a real estate holding company. Last Memorial Day he was honored in his hometown newspaper for service to his country. He spent 14 months in France during World War I, where he was involved with

the transport of troops from training centers in France to the front lines. He finished the war as a captain.

A widower for the last 10 years, Lough now lives with his daughter and son-in-law (Evelyn and William Montgomery) in Grosse Pointe, Mich. He is a member of the Grosse Pointe Senior Men's Club, plays duplicate bridge several times a week, reads a great deal, and enjoys visits with his grandchildren and great-grandchildren. He also used to be a golfer and a musician.



from 1942 to 1946. On April 5, 1949, he received the Congressional Legion of Merit Award. He retired from the Army in 1964. He was involved in professional services, many civic societies, and the Yacht Club, where he was in five races. He was especially liked for the way he got along with people. . . . **Richard W. Carlisle** of Ogdensburg, N.Y., died December 12, 1988. He leaves his wife Margaret. They have two sons and one daughter, plus grandchildren and great-grandchildren. Richard had more than 50 patents in his name.

William H. Hamilton of Clarksboro, N.J., died May 1, 1989. He leaves three daughters and one sister Adnee. William was a civil hydroelectric engineer and worked for the U.S. Bureau of Reclamation, and Stone and Webster Engineering Co. . . .

In two previous issues I have outlined the expertise of Doctor **Peter L. Belleschi** of Portland, Ore. Here is more detailed information regarding how to avoid being hit by lightning. "When a thunderstorm threatens, avoid open spaces, leave golf courses, avoid isolated trees and metal fences. At work in fields, on horseback, or out in an open boat, get under cover. If in your car, stay in it. Don't get on top of a mountain. It is dangerous to build fires under high-voltage transmission lines."

You can be of great help to MIT and help yourself at the same time. A contribution of stocks to the Compton Fund will provide income to you and your wife as long as either of you are alive, and that income will be two or three times what you are getting in dividends and you can reduce your income tax by tax-deductible contributions. Consider this seriously.—**Donald S. Cunningham**, secretary, 27 Lowell St., Braintree, MA 02184

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From a telephone call with Harriet and **Carl Davies** in Charleston, I have first-hand information about the damage from hurricane Hugo. It was the worst of five storms they had experienced. They were fortunate that their home was not severely damaged. Their daughter, Penny, had four feet of water in her basement and lost all her appliances and her car. They lost water, electricity, and telephone for a full week, and only 23 percent of the people in their area had received power after a week. Ice and dry ice to preserve food were scarce. They claimed that the spirit of assisting others was wonderful and helped overcome this disaster.

A recent visit by **Maurice "Maury" James** and son Sam was a pleasure, as we have not met since our 50th reunion. They have a tree farm in Northwood that has been in their family since 1793. They were awarded the "Tree Farm of the Year" for their County and they harvest firewood regularly and construct fire roads. Their old home has been made into apartments that are rented to students. Maury retired in 1970 from Bucyrus-Erie Corp. as administration manager of International Operations. He lost his wife, Jo, this year after 57 years of marriage.

Elwood A. Church died August 4, 1989, in Brattleboro, Vt. His career was with Boston Edison, where he was in charge of systems planning for the last five years before he retired in 1968. He lived in Marblehead for more than 40 years. In 1977, Elwood traveled into the interior of British Columbia, including a raft excursion on the rapids of three rivers. The trip involved camping out for nine nights in the wilderness. He was a member of the Wilderness Society, National Audubon Society, and was a loyal church member. We enjoyed meeting his wife Elinor at our 55th and 60th reunions. She now lives in their home in Brattleboro, and we send her our condolences.

L. Dale Stetson died July 29, 1989, in Warren, Vt. He was chairman of the Architectural Student Council in his senior year at MIT. As a close friend and fraternity brother, I can vouch for him. Dale went to New York and pursued stage designing during the Depression. He designed

store fronts for Macys and subsequently worked for J.C. Penny Co. He became design manager of all their stores for many years and accepted retirement in 1965. He and his wife, Pat, left New York for the hills of Vermont, just one mile from the famous Sugarbush ski resort in the Green Mountains.

I have enjoyed their hospitality on annual visits over the recent years. Their home is filled with antiques and collected books. Pat now lives in the Grist Mill House in the quaint town of Warren. We send Pat and daughter Nancy our deep sympathy.—**Joseph C. Burley**, secretary, North River Rd., Epping, NH 03042; **Lawrence B. Grew**, assistant secretary, 21 Yowago Ave., Branford, CT 06405

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To all of you we wish a very good start into this fresh new year and into a new decade that will be the last one of this century. Who of us starting out together in 1924 ever expected to come this far in time? Yet a surprisingly large number of our classmates report themselves as active professionally or in business. In our current list of 229 classmates, 32 say they are still at work—at least, to some extent. That comes to 14 percent—not too bad for a class of octogenarians! In addition, no doubt, there are many others still busy with volunteer jobs or tending their personal affairs. Class of '28 always has been and apparently still is a good vigorous class.

Several months after the death of **Gerry MacGillivray**, his son, Kenneth, wrote us a most interesting letter. He recalled how he accompanied his parents in 1953 to the '28 25th reunion (the first MIT family reunion ever to be held on campus) and how grown up he felt in having his own dormitory room. He says he was simultaneously "smitten" on that occasion by two of the alumni daughters, **Ralph Jope's** daughter, "Rocky," and **Bill Birch's** daughter, Dagmar Ann. He corresponded with the latter for a couple of years thereafter and also visited the Birch family several times during that period. Kenneth is now an airline captain with a beautiful grown family of his own. His wife is a fifth-grade teacher who gives special attention to the space program for the benefit of her science class. She was named Virginia Beach (71,000 children, 3,600 teachers) Teacher of the Year. Ken, Jr. (Gerry's grandson) is just now about to graduate from the University of Virginia with his degree in chemistry. His love of chemistry always delighted Gerry who, as you may know, graduated in Course 5.

Florence and I (your secretary) attended the Alumni Leadership Conference, which was held at the Institute on September 23, 1989. It was a one-day event but with a very busy schedule from early morning to evening. The subjects presented and discussed were largely in the common interest areas between the Institute and the alumni body. Included were such matters as admission policy, educational programs, finances, and the various aspects of alumni support. The overall program was well planned and the attendance outstanding. **George Palo**, as an Educational Council member, was scheduled to attend. Unfortunately, Ann became ill and their trip had to be cancelled.

With deep regret we must now report the deaths of two classmates. **Paul A. Jones** died August 19, 1989. Paul prepared for MIT at Phillips Exeter Academy and entered with our freshman class in Course 15, business and engineering administration. He left us after two years but later continued his student career at Bowdoin College and at Boston University School of Medicine for his M.D. His life work was in medicine and psychiatry. During World War II, he served in the U.S. Navy Medical Corps (lieutenant commander) then returned to his practice in Union, Maine. Besides his wife, Louise, Paul leaves two sons, two daughters, a stepdaughter, many grandchildren, many great-grandchildren, and four great-

great-grandchildren. . . . **Adolph E.C. Maertins, Jr.** died July 24, 1989. Adolph graduated in Course 2, mechanical engineering. He held various engineering positions during his early years then joined Henry S. Wolkins Co. in Walpole, Mass., where he was president and treasurer for most of his business life. Besides wife Janet, Adolph leaves a daughter, four grandchildren, and two great-grandchildren. To the families of these departed classmates we extend our heartfelt sympathy.—**Walter J. Smith**, secretary, 37 Dix St., Winchester, MA 01890; **Ernest R. Knight**, assistant secretary, Box 98, Raymond, ME 04071

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I have a few post reunion letters. . . . **Harold M. Weddle** and wife Esther of San Diego, Calif., write, "We have recovered from that lovely trip. One of the nicest parts was to meet you and enjoy your company along with others. We sure would like to meet some of them again. The program was nicely arranged, as we seemed to be hopping right along and everything was joyful and interesting. We drove back to Hartford, and our son met us and drove us back to Chappaqua (where we stayed one night), then drove us to the John F. Kennedy Airport. There is no question now—life really begins at 80!"

From Isabel and **Jonathan F. McCray**, Heber Springs, Ark.: "I wish publicly to acknowledge the debt we all owe to **Jerry Gardner** and his gracious wife for arranging such an enjoyable reunion. As you remember, we had to fly to the 50th reunion because of gasoline shortage. This time Isabel and I were looking forward to an enjoyable drive to the 60th. Unfortunately, the AAA arranged our tour through New York City, where we experienced congestion and rough roads. On our return, we changed our route, which was quite enjoyable. Last October I had a cataract removed from my right eye and an implant installed. The resulting improvement was not that great, so today my ophthalmologist performed an encapsulotomy by means of a YAG laser. It is too early to tell the results, but we hope for the best."

Robert S. Pride and his wife Marion, whom we have known from high school days, wrote to thank us for their visit with us in Hampton, N.H., after the reunion. They say, "We are now back into the routine—doing the laundry, going to the library, shopping, and maybe a little sailing (weather permitting)."

Frederic Celler of Maitland, Fla., writes, "I am now in a wheelchair because of arthritis. No more golf and no more annual trips to France. We are always interested in news about our classmates. Thanks for your continued efforts as class secretary." The Cellers have one child, one grandchild, and one great-grandchild. Hobbies? Observing world evolution.

Betty and Virgil W. McDaniel have changed their residence from Guilford, Conn., to 269 Essex Meadows, Essex, CT 06426, (203) 767-0362. . . . **Norman M. Wickstrand** of Harwinton, Conn., writes, "Last March we moved to the Gables apartments (206 E). This is a retirement home where we get dinner in the evening in a common dining room. Most of the residents are, like myself, in their 80s. It seems to be the best solution, but it is far different from living in a single home in a small town." . . . **Paul S. Baker** of Williamsburg, Va., writes, "Thank you for **Larry Waite's** address and telephone number. He was in my Course XVI. I was able to speak with him by phone on Saturday, and he sounded pretty well considering all that he has gone through. It had been over 40 years since I had contact with him. I also heard from **Bob Riley**, another Course XVI member. He is making a good recovery from a terrible automobile accident last October—his car was rammed by a pick-up truck."

I regret to inform you of the deaths of **Joseph Green** of Coconut Creek, Fla., on July 31, 1989, and **Sydney Curtis Hardwick**, of Clearwater, Fla.,

on June 10, 1989. Joseph Green moved from Belmont, Mass., to Florida about 10 years ago. He was an active member of our class, attending most of our class functions. In Florida, he joined the MIT Club of Fort Lauderdale and attended the super Florida Festival about eight years ago at Cypress Gardens. He lost his wife a few years ago, which changed his mode of living—he was very lonely. He is survived by three daughters and one son. I received a note from **E. Neal Wells** of Pinellas Park, Fla., that Sydney Hardwick had passed away after a long disability following a stroke.—**Karnig S. Dinjian**, secretary, P.O. Box 83, Arlington, MA 02174, (617) 643-8364

30 60th Reunion

As mentioned in last month's notes, our 60th Reunion Committee comprises chairman **Yicka Herbert** and members **Ed Pritchard** and **Tom O'Connor**. Earlier this month (September) I attended a Cambridge planning session of this committee at which a tentative reunion program was adopted, beginning with arrival at MIT on Thursday afternoon, June 6, and ending after breakfast on Saturday, June 9. Since you are scheduled to receive an October letter with program details, I won't repeat them here. Yicka has initiated an intensive telephone campaign to persuade as many of you as possible to attend.

As previously reported, **Bill Alling**, one of our three clergymen, has in recent years been associate pastor of the Reformed Presbyterian Church in Huntsville, Ala. In June 1988 he was asked to preach at the Bible Presbyterian Church in North Olmsted, Ohio, the same church he attended some 40 years ago when he first decided to enter the ministry. So at age 81, Bill has taken on a new responsibility. He says that "the small congregation is very appreciative of all that I do. The church has had very rough sledding for several years—there are problems that only the Lord can solve." . . . **Bob Armstrong** writes from East Dorset, Vt., that his "main activity still is helping my wife with her sculptures." Jane's sculptures are scheduled to be shown at the Grand Central Galleries in New York City later this year.

Reg Bisson recently sent me an update on his previously reported manifold activities. He is sole owner of a construction company in Laconia, N.H., a consulting engineer, and senior trustee of the Laconia Savings Bank. Last March Reg underwent triple bypass surgery at the Maine Medical Center, seven weeks after his son William, '60, underwent the same operation by the same surgeon. Reg has apparently recovered fully from his surgery, since he reports that he and Adrienne have no difficulty getting around, either walking or driving, and look forward to celebrating their 53rd wedding anniversary. Last summer his grandson Andrew, a member of the Boy Singers of Maine, performed at Dubrovnik, Yugoslavia, with the Petrograd Symphony Orchestra.

Bob Cook's development of his Buildorama Sets, an array of notched panels that can be used as modules in the construction of model buildings, was reported in the August 1986 issue. He has continued to expand and elaborate this concept, and hopes to offer them for sale at the MIT Museum shop.

Once again we have some downbeat items to report. A brief note from his wife Muriel, brings the sad news that **Jim Morton** suffered a severe stroke last July and is now in a nursing home in Sarasota, Fla. . . . Also, we have a delayed notice that **J. Palmer Boggs**, known during his MIT years as "Peat," died June 12, 1987, in Missoula, Mont. He was for many years a professor of architecture at the University of Arkansas, from which post he retired in 1976. As of December 1985, the date I last heard from him, he was still living in Fayetteville, Ark., and doing consulting work in structural engineering, as well as caring for his wife Virginia, who was mostly bedridden. My records indicate that he is survived by three children: a son James P. Boggs II, with whom he

was apparently living at the time of his death, and two daughters, Meredith Denning and Dr. Jacqueline West. I don't know whether Virginia survived him.—**Gordon K. Lister**, secretary, 294-B Heritage Village, Southbury, CT 06488

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This job as temporary class secretary is a new animal in my menagerie, so I hope you will tolerate me until I really get my feet on the ground.

Louise and John Swanton report that they have had some pleasant visits at their half-year summer home on Westport Island, Maine, from two classmates at different times. At the time of the Antique Boat Parade and Windjammer Day at Boothbay Harbor in July, **Joe Buswell** (previously of Washington state, now Sun City, Ariz.) was able to join the Swantons, with his longtime family friend Hortense Burley, for an interesting double circuit of the harbor in John's son Jack's 1929 60-foot motor cruiser. The cruiser has been Jack's and his wife's home for many years; now they are permanently established ashore on Westport with their newly adopted family, but still have the boat.

More recently John Swanton had a note from **Al Sims**, who was joining with other railroad enthusiasts to take note that Canada is considering eliminating all passenger railroad travel in the maritimes. They planned a route including Moncton, Campbellton, Gaspé, Edmundston, St. John, Yarmouth, Halifax, Sydney, Truro, and Prince Edward Island, then stopping with a visit to Al's daughter near Portland. Al called Joe Buswell from there as he knew Joe was at North Edgecomb (near Westport). John called both of them and they all got together at John's place in Westport: Al and Lillian Sims, and Joe Buswell and his family. They had a nice trip in John's 25-foot inboard to Boothbay Harbor, with lunch at the lobster wharf on Southport Island on the way home. John says they had a chance to remind themselves that our 60th reunion is now only 20 months away.

Maurice Llewellyn Sellers died May 3 at Williamsburg, Va., Community Hospital. He worked for 47 years at Newport News Shipbuilding and Dry Dock Co. as a naval architect and supervisor of hull design. He is survived by his wife Mary of Williamsburg, Va., son George of Brookline, Maine, daughter Mary C. Dunn of Richmond, Va., two grandsons, and a great-grandson. Apparently he had a great love for his birthplace as his family has requested that memorial contributions be made to the Maurice L. Sellers Fund, Friend Memorial Library, Brookline, ME 04616.

We have just learned that **Madeline L. Anderson**, who apparently was with our class from 1930 to 1931, died July 15, 1986. She taught mathematics in Boston and Brookline high schools.

The last word we have on our long-serving class secretary is that he is still in a nursing facility since he requires care beyond the capabilities of his dear wife. But he is improving, and they hope to attend our 60th reunion in 1991.

We have received information that **Gilbert Ayres** died November 6, 1988. His father, Rev. Samuel Gilbert Ayres, was a pastor of the First Universalist Church in Woonsocket, R.I. In 1919 he resigned his position and went to Japan as a missionary. Gil lived in Japan with his parents from 1919 to 1924, then came to the states and graduated from Brookline High in 1927. After graduating with us he stayed on for his doctorate, which he received in 1934. He worked for American Cyanamid as a research chemist until Pearl Harbor, when he was ordered to active duty and assigned to the 37th Infantry Division. Since he was conversant in Japanese, he was responsible for interrogating prisoners and translating Japanese documents. He returned to his family in 1945 and retired from active duty as a lieutenant colonel with a bronze star and an oak leaf cluster. Gil went back to work at American Cyanamid as

research director, working with Lederle Laboratories at Pearl River, N.Y., at Bethel, Conn., in 1954, and Wyckoff, N.J. in 1963. His interest in religious matters continued all the while, and in 1973, after study at the Newark School of Religion, he was ordained a deacon at the Church of the Good Shepherd. He returned from American Cyanamid World Headquarters, where he was technical director for overseas operations in 1974.

In June 1985 Gil and his wife Charlotte celebrated their 50th wedding anniversary with their five children and their families. Writing of Gil's retirement, a friend of his said: "The Rev. Dr. Gilbert Ayres was a busy man. He pursued his keen interests in gardening, music, reading, and the church. His active concern for world hunger and local programs of outreach as well as a personal concern for members of the parish were uppermost in his life. His encyclopedic knowledge was usually hidden behind his quiet humor until an answer was needed. He usually appeared with his tool box before others realized something needed fixing." I cannot think of a greater tribute to Gil.

John Spalding has reported he married a California girl in 1986 and moved to 7064 Overland Dr., Santa Rosa, CA 95409 a year later. Says he has had both his valves replaced a year ago and now does his three 18 holes each week.—**Wyman P. Boynton**, acting secretary, 668 Middle St., Portsmouth, NH 03801; **John Swanton**, assistant secretary, 27 George St., Newton, MA 02158

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There can be a life after retirement. In 1974, **Irv Kalikow** retired from General Electric, where he was involved with work on aircraft engines, aircraft accessories, armament buildup. He embarked on a consulting career designing eye surgery equipment for use in the new procedure for operating on the retina and vitreous, which in the past were considered inoperable. Some of the new tools help to restore sight for those who would have been forced to live in certain blindness. He writes, "My most important hobby has been and is the development of time-lapse photography of flowers growing from seed to blossom and putting the sequences to music and commentary. The films I have put together have been awarded many prizes, and I show them to garden clubs and organizations. We have two granddaughters at Harvard. Our daughter is dean of New Hampshire State University at Plymouth, and our son is a consulting/project engineer at Digital."

We were pleased to learn that our classmate **Russell Robinson** received the Harold E. Lobdell, '17, Distinguished Service Award largely for his sustained work for the MIT Club of Dallas/Fort Worth. Congratulations! . . . **Arthur Marshall** writes that he was unable to attend Technology Day 1989 because of a fire that destroyed his office in Springfield in May. He is hoping and planning to attend Technology Day 1990 with his wife, Ree. . . . **Edmund F. McLaughlin** and wife have discovered a new dimension of travel—hostels. They have been to Bristol University in England, Canterbury University in New Zealand, and an Elderhostel in Greece. He is enthusiastic about making more trips.

The Alumni Association brings me news of some of our classmates who died. **George L. Green**, 82, died in June 1989. He held executive positions for the *Providence Journal-Bulletin* for 22 years. He retired in 1971 as assistant vice-president of production. He was active in many organizations. He leaves several nieces and nephews. . . . Reverend **John Patterson** died in November 1989 in San Francisco, Calif. Educated as an architect, he tried that profession, then entered Seabury-Western Seminary at Evanston, Ill., to become a priest. While he was rector of St. Mary's Parish in Mitchell, S.Dak., before World War II, he enlisted the aid of Eleanor Roosevelt to

found a church children's aid society that still exists there. In 1939 he was named a fellow of the American College of Preachers in Washington, D.C., the first of many honors for his innovative work in the church and with church liturgy. In 1951 he was named a doctor of divinity by Seabury-Western. In 1961 he was awarded the degree of Doctor of Sacred Theology by Hobart and William Smith College in Toronto, Canada. He was co-author of a book, *Before the Holy Tabernacle*, published in 1959, and author of *Liturgical Renewal of the Church* in 1961. He leaves his wife, Elizabeth, and four children.

Charles Fenno died in June 1989 in Cincinnati, Ohio. He retired recently after 30 years with Union Carbide as a consultant. During World War II, he was a lieutenant commander in the Navy. He leaves three daughters and two sons. . . . **William Warrick** died in September 1982 at Ormand Beach, Fla.

My wife Ruth and I celebrated our 20th anniversary and took a cruise up the Norway coast into the Arctic Circle. It was a beautiful experience. I am still active in work, tennis, golf, organizations, etc. However, in September, I got a bleeding ulcer that brought me to the hospital. Fortunately, after a quick recovery, I resumed normal activities. I realize that some day nature will have the last word and make me curtail my activities, but that day is not yet.—**Melvin Castleman**, secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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This is being written three days after Hugo made landfall about 50 miles north of my home and, as you know, devastated Charleston and environs.

Obituaries: **Robert Timbie** died February 16, 1989. He was an engineer in research and development at Monsanto in Pensacola. Mrs. Timbie's address is 1129 E. Dunmire, Pensacola, FL 32504. . . . **Donald MacCormack** died August 1, 1989, at his home (Pearl Lake Rd., Sugar Hill, NH 03585). Mrs. Eleanor MacCormack still resides at the above address. Don had degrees from Dartmouth College as well as a degree in architecture from MIT. He had been chief architect and project manager at Brookhaven and was a longtime member of A.I.A. He had a personal interest in the historical roots of Sugar Hill and its original settlers as well as the geological history of that area. . . . **George E. Hughes** (colonel), 1120 Milky Way, Colorado Springs, CO 80906, died May 9, 1989. We have no further information. Mrs. Hughes may be reached at the above address.

More about **Beau Whitten**. Fred Sadri, '50, an avid reader of Class Notes, noticed our reference to Beau. Since Sadri lives in Charlotte, he dropped in to see Beau, and reports that he is being beautifully taken care of although his memory at times is "in and out" (whose isn't?). Beau has full-time coverage and can be reached at (704) 553-1670. Nice of Fred to do this.

A mention of **Walt Skees** in the *Review* prompted communications from **Converse Sweetser**, 134 Maple Hill Rd., Huntington, NY 11743. Sweetser not only contacted Skees but also **Richard Molloy**, 1214 Bluewater Dr., Sun City, FL 33570, and **George Bentley**, P.O. Box 1051, Conway, NH 03818. He quotes the British Army song from the Sepoy mutiny, "We Stand for the Last Time Together." He also recalls the last GAR encampments and knew personally a Civil War veteran.

Sweetser was at Grumman for 43 years starting at \$14 a week until a big promotion into engineering at \$20, where he worked on the F-111. He also worked on the TBF, in which George Bush was shot down. Bush was picked up by the submarine *Finback*, the engines of which were later put in the Bridgeport-Port Jefferson Ferry, where Sweetser's son is now chief engineer. He has been married 47 years, sings in the church choir men's chorus and mixed chorus, and writes program notes. He is also interested in church

history and liturgy and is a licensed lay reader (Episcopalian).

Ivan Getting, president emeritus of the Aerospace Corp. in El Segundo, was presented with the Founders Medal of IEEE on June 2 in San Francisco. He was cited for "leadership of critical programs and enterprises in radar, advanced electronics, space and navigation as well as service to the engineering profession." Before he was at Aerospace, he was vice-president of engineering and research at Raytheon. From 1940 to 1945, he was with MIT's Radiation Laboratory, where his group developed the first automatic microwave-tracking fire-control radar that was credited with saving London and later Antwerp Harbor. He received a doctorate in physics from Oxford University as a Rhodes Scholar. He was a member of the National Academy of Engineering and American Academy of Arts and Sciences and was president of IEEE in 1978.

The next issue will include reference to the class officers meeting held in Cambridge October 31. It will also include an early report on the Cardinal and Gray Society meetings scheduled for Alumni Day 1990!—**William B. Klee**, secretary, P.O. Box 7725, Hilton Head Island, SC 29938, (803) 785-7746

34

Wing Fong Wu writes to thank us for making his trip to the U.S. for our 55th reunion possible. He also thanks us for the MIT blazer. Immediately after Wing's return to China, he was invited as a "guest" (read "honorary chairman") of the second Asian-Pacific symposium on wind engineering; the work under study was the Fragrant Hill Hotel in the western outskirts of Beijing. This recognition of his stature shows that he has not suffered from his exposure to "capitalist devils."

The January 1989 class column mentions **Mel Souza**, primarily with regard to his hobby of training and showing horses. Mel and his wife, Winnie, came East for the reunion, and I was able to gather some information about his career in the aerospace field. In the years before World War II, he did design and systems work with North American Aviation, General Electric Flight Propulsion Division, and Cornell Aeronautical Laboratory. During the war, he was chief structural engineer for Fairchild Aviation. During these years and into the 1960s, he presented papers at technical meetings on both coasts of the U.S. and in Milan. In 1967, Mel joined McDonnell Douglas, where he worked on the design and evaluation of a number of planes such as the Hawker-Siddeley Harrier, various V/STOL designs and the DC-10 series. He has been a senior planning advisor concerned largely with special studies for management and customers on commercial market development. Before retirement, he held the position of manager of aircraft analysis.

Since our reunion, I've had a letter from **Ed Asch**, who was part of the group who worked to bring **Wing Lem Wu** over from China. Ed said that because they wanted to do some visiting en route to and from Boston, they drove (from Houston, that is!). One stop off was on Long Island with Barbara and **Charlie Mack**. Because Barbara has difficulty walking, the Macks had to pass up the reunion. Ed went on to comment about his career. Since he went with Vickers Hydraulic (of the old Sperry Corp.) in 1940, he has been involved intimately with almost every conceivable industry. He lists "naval and civil vessels, tankers, carriers, machinery, and mechanical devices of all types (presses, glass machinery, farm, and construction)—you name it, I had something to do with it."

As usual, I have several losses to report. One, with very little information, is Lt. Col. **Arthur DeGregory**, who died in the VA hospital in Bedford, Mass., on October 11, 1988. This information comes from a son, Michael, who lives in Honolulu. He also leaves two sisters and a number of nieces and nephews in the Boston area.

On November 18, 1988, **Charlie W. Bechle** died in Sycamore, Ill. He had worked for Anaconda Wire and Cable for 37 years and retired in 1972 as technical manager. He held numerous patents relating to the manufacture of wire and cable, was a registered professional engineer, and a life member of the American Chemical Society. Bechle is survived by two sons, a sister, and two granddaughters.

On May 19, 1989, **Joseph Drankowski** passed away in San Carlos, Calif. Drankowski was a native of Salem, Mass., and had worked for various aerospace companies. He had lived in California since 1961 and retired from McDonnell-Douglas in 1969. He had resided in San Carlos since 1984, where he is survived by a son and three grandchildren.

My last item is rather hard for me to set down—the death on September 28, 1989, of **Eric J. Isbister**, my oldest and closest friend. We had met at the freshman camp before school began in 1930, and in reasonably short order we were part of a group of six or seven who got rooms together in the then new Monroe section of the dorms. This group stayed pretty much together for all four years. Following graduation, Eric worked for Sperry Gyroscope Co. on Long Island, and by 1957 he was chief engineer of the Surface Armament Division. In 1961 he went with Radiation Inc. in Melbourne, Fla., and from 1964 to 1970 he was with Hazeltine Corp. back on Long Island. In 1970 he returned to Sperry, this time as a consultant, both in Virginia and in Ottawa, Canada.

During and after World War II, Eric was responsible for airborne and surface radars, beacons, and loran systems. In recent years, he directed studies and system design for shipboard and harbor traffic control radars all over the world; one of the latest was one in Milford Haven, Wales, UK. This port handles a major part of Britain's petroleum traffic, and the system includes four radar sites feeding a central control station over microwave links. He was a fellow of the IEEE, had published numerous articles and papers, and held 24 patents.

Eric is survived by his wife Mora, two sons, a daughter, and six grandchildren. He was responsible for my going to Sperry in 1940, where I picked up again and carried forward our friendship that had started in 1930. To Eric's family and the families of the others I have mentioned in these notes, I would extend the sympathy of all our class members.—**Robert M. Franklin**, secretary, P.O. Box 1147, Brewster, MA 02631; **George G. Bull**, assistant secretary, 4601 N. Park Ave., Chevy Chase, MD 20815

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55th Reunion

After being only 40 miles from **Jack Holley** in Chula Vista for many months, I finally had a good chat with him by telephone resulting in the following letter: "I think you failed to get a previous note about a personal plumbing job I had in November 1987; four pipes to bypass some clogged ones. Nothing much notable about this except that I was in the recovery room on the sixth floor when an earthquake hit San Diego. I was swayed by the grandeur of nature. By Xmas I was pretty well my old self so that Spring, my wife, and I spaced 'A' to Manila to visit with her extensive family. (My retirement military income is the major benefit of 'Advanced ROTC'—remember ROTC?—but that Space A is no small bonus.) The big news today is the arrival of Ashley Nicole Mizeski—my first great-grandchild, last August 26. You can understand my glorious feeling of fruition when you realize that my oldest grandchild is 33. Outside of the foregoing, innumerable minor items keep me occupied, and a busy guy is a happy guy."

Edie and Ham Dow have completed their move from Rancho Bernardo to Escondido. Everything is inside the front door, but now comes the sorting out. After a hiatus of about six weeks, I am

happy to have my golf partner back for our weekly sunrise match. Yes, Ham got hypnotized and we have played twice since; our scores have been in the 78 to 82 range. . . . From **George Kevorkian**, Wakefield, Mass., comes a note updating his involvements: "Golden Rule Lodge, Wakefield; commander, Knights of Vartan, Cambridge; trustee, Building and Grounds, First Armenian Church, Belmont; president, Men's Club. . . . **Luis W. "Bud" Pfanz** writes for the benefit of any classmate who "hasn't already fled cold frigid crowded Massachusetts" from his home in Sierra Vista, Ariz., extolling the advantages they have there at 5,000 feet above sea level. The highlights: Summertime temperature, 90 to 100 with humidity below 20 percent, 10 degrees cooler than Tucson and 20 below Phoenix.

I am sorry to report the death of **George W. Bartlett** last June 12 at his Centerville, Mass., home. After 13 years with the Naval Air Material Center in Philadelphia, 13 years with McKierman-Terry Corp. of Harrison, N.J., and seven years with KPT Manufacturing of Roseland, N.J., he worked for the CPC Manufacturing Corp. of Sturbridge, Mass., from which he retired in 1987 as consultant. Our condolences go to his wife and family.—**Allen Q. Mowatt**, secretary, 715 N. Broadway, No. 257, Escondido, CA 92025

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The October Notes mentioned my sending two old news clippings, circa 1935, of our Tech basketball team to **Dick Denton**. He replied with a photocopy of the teams pictured in the 1934 *Technique*. Dick was a substitute then and made the varsity in junior and senior years. I sent photocopies to our surviving classmate members, with the following results. A note of thanks from **Chuck Kennedy** at his summer home in Stone Harbor, N.J.: "It will be quite a while before I play basketball again. I'm afraid the Celtics are not going to pick up my option." Chuck reports that his health is about the same as when I visited him in May 1988 while he was in extended care at the Elmira Hospital. His fortitude and good cheer bring to mind the examples cited in the best-seller *Love, Medicine and Miracles*.

A note from **George Crumme**, manager of the frosh team that year and later varsity manager: "Many thanks—the pictures bring back some great memories" such as beating Harvard in senior year, as recalled by Dick. Dick was asked to write an article on the start of vacuum coating of lenses at Frankford Arsenal during World War II, and it appears in *Optic News*, (July, 1989), the journal of the Optical Society of America. Only a stick-to-it engineer could overcome the problems of material shortages, production handicaps, make-do solutions, etc. that were necessary to give our fighters night vision equal to or better than our enemies. Quoting the editor's introduction, it is "the story of someone who took part in shaping what we now call history. Denton was honored by the Optical Society in April 1988 as one of our industrial pioneers."

Readers must surely have noticed that for some issues of Notes my typewriter runneth over. The August/September Notes had to be shortened by the Review staff, omitting something from my visit to **Jim Craig**. On request, he provided another item: "I remember working for Jim Kilian as a sales representative in the dorms for the Review before his rise to the top. **Dick Denton**, myself, and the rest of the '36 Field Day football team were just outclassed both years. I had fun on the wrestling squad and gym team, and got a second in New England intercollegiate 126-pound wrestling. The peddling and distribution of the *New York Times* and studies left little free time."

A letter from **George Ray's** widow, Nancy, tells of his being elected posthumously to the Niagara Frontier Aviation Hall of Fame, joining Larry Bell and other aviation greats. Our tribute to his life was in the January 1989 Notes, to which could be added a host of accomplishments as chief en-

gineer in developing VTOL aircraft, directed propellers, air-cushion landing craft, etc. Nancy also included a copy of a 1924 letter to "Master George Ray" (age 10) from Chief of Army Air Service H.L. Martin. Martin had piloted one of the seaplanes in the 1924 round-the-world flight, and George made a model of the plane and sent it to him. Martin replied: "I hope that your interest in aviation development will lead to your having a position of prominence in this great industry." Indeed it did, and as Nancy put it, he was headed for MIT (and Course XVI) early on.

Bernard Gordon, Course I, writes, "Am now in semi-retirement which includes some consulting time in civil engineering in the field of water resources, design or construction of embankment dams. Some time is also spent on work for professional societies and guest lecturing in graduate programs and short courses of continuing education." That's the way, Bernie—keep your hand in and your interests alive!

A clipping from the Stamford, Conn., *Advocate* tells of **Leon Simons** (Course II) winning a patent for a new design of the "humble screw, which dates back to the fifth century B.C." He designs for Southern Fastening Systems of North Carolina, which has sold hundreds of millions of the products, and he has licensed an English manufacturer to produce "Simons Head" screws that resist stripping. The 1989 *Alumni Register* lists his business, Orapoint Corp., at Pearl River, N.Y., and I hope to visit him and several other classmates in northern New Jersey on my next trip east.

When reading John McPhee's "Up From the Plains," my thoughts turned to **Bob King** and **Doug Woodward**, both of whom served with the U.S. Geological Service for many years. It is the story of geology (primarily western) as seen through the eyes, and recorded in numerous papers, of David Love, a giant of that profession. So I dropped a note to the two classmates, and from Wheatridge, Colo., comes Bob King's response. "Dave was my graduate teacher at the University of Wyoming summer camp in 1935. Since that time we have been associated professionally in the U.S.G.S. McPhee includes tales and descriptions of familiar places. Many geologists learn the paradox of life: how to develop natural resources yet keep a responsibility to preserve or conserve these resources as much as possible." Bob had a heart bypass in May 1989 and cataract surgery in July, and reports that the replacement parts are working well. He received a greeting from **Al Horner**.

Let's cheer the life of **Richard "Pete" Farmer**, who died June 4 of a sudden embolism at Marco Island, Fla. Pete joined our Course V as a graduate student from the University of Alberta and had a wide-ranging, successful career in chemicals and mining. He retired in 1979 as president of Illinois Nitrogen Division of Borden Chemicals. Along the way he was superintendent of uranium operations in Ontario, won an AEC award for work on the bomb, was superintendent of Cornate Phosphate Co. in Florida, manager of Texas City Chemical, and director of research for Smith-Douglass Co. in Virginia. He met his wife, Georgina, shortly after graduation when he was mining copper and gold at Noranda in northern Quebec. She had gone there to teach school and wound up with a long happy marriage. Best wishes to her as she continues at The Prince Condos, Marco Island 33937.—**Frank L. Phillips**, secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, assistant secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Henry Blackstone, 1416 Ridge Rd., RFD Laurel Hollow, Syosset, NY 11791, resigned and retired as chairman of the board and director of Servo Corp., Hicksville, N.Y. The Dow Jones News Wire reported on March 2, 1989, the merger of Servo

Acquisitions, Inc., with and into Servo Corp.

Winthrop A. "Win" Johns, 29 Yacht Club Dr., No. 306, North Palm Beach, FL 33408, writes to tell us about an accident he had—a fall resulting in a dislocated shoulder—in December 1988 when he and his wife, Alice, were vacationing in New Orleans. Various complications developed, necessitating intravenous feedings. "Although I graduated from MIT, I joined the IV (Ivy) League," he quips. He lost about 33 pounds over the course of treatment, mostly due to infections. Win reports (as of last September 23): "I am just now able to swing a golf club. I have not fully recovered my strength and stamina, but it is improving day-to-day. I'm hoping I'll be back in shape when our golf course reopens November 1." We wish him well.

Joseph H. "Joe" Stone, 4 Cushing Ave., Brockton, MA 02401, retired as an engineer from Raytheon in September 1982. Wife Angie's main interests are home and bowling. She is a retired teacher. Joe writes, "I really have no intense hobby; keeping the properties in shape—house in Brockton and summer home in Maine—is enough to pass the time. Still do specialized consulting with Raytheon. No extensive travels. My wife and I are reticent to travel by air, so where in blazes can you go? We do get away, by car, in the winter for warmer climates (after Christmas, of course). The children and grandchildren would never permit us to forego celebrating this occasion as a family tradition and gathering of the clan."

Michael Zinchuk, 145 Gosnold St., Hyannis, MA 02601 enjoys photography, archery, and studying Russian. His wife, Ann, reads, enjoys people, and volunteers for the Barnstable Conservation Foundation. During September 1988, they toured Alaska and returned on the S.S. *Noordam*. In July and August 1989, they took an MIT cruise on the Volga River in the Soviet Union. He writes, "The two trips deserve comment. If one goes to Alaska for the purpose of viewing wildlife, he will, on the average, be disappointed. If one is satisfied viewing wildlife the size of golf balls and smaller, fine; the game is so far off that they look that size. In order to photograph the game, one should backpack into the area. Photographing through a bus window with a full complement of people is frustrating."

"The trip down the Volga was fascinating. One can't imagine the size of the river until one is on it; at points it is 30 miles across. Tours are a tiring experience. The amount of ground covered during the day is an aerobic exercise, with the added bonus (if one is inclined) to be awakened at 4:30 a.m. to start a day trip. I find there are two types of people who go on a tour. The first group have a specific interest (photography, people, architecture, environment, farming, churches, museums), and the second group are those that are gathering information for this statement. 'Don't tell me, I was there.'"

Your class secretary would be most grateful for a copy of holiday greeting letters you may have sent out. Please edit the information, deleting what you don't want published.—**Lester M. Klashman**, secretary, 289 Elm St., Apt. 71, Medford, MA 02155

38

Last May's notes mentioned briefly that Muriel and **Norm Leventhal** had endowed a full professorship in the School of Architecture and Planning. Now, several classmates have sent your secretary copies of an impressive article from the *Boston Globe* (August 15) about Norm's Beacon Companies. Originally founded by Norm and his late brother Robert, '36, it remains a family-run organization of only four general partners. Norm as chairman, his two sons Alan and Mark, and son-in-law Ed Sidman. At first a small construction company, Beacon Companies now consists of Beacon Hotel Corp., which runs 27 hotels nationwide; Pemberton management, which operates 5,000 housing units; Beacon Management Co.,

which oversees 6 million square feet of commercial space; and of course, the Beacon Construction Co. In the 1980s Beacon built three of Boston's most prominent buildings. Most impressive is Boston's smash hit Rows Wharf, a spectacular complex on the harbor consisting of condominiums, office space, and the 230-room Boston Harbor Hotel.

In view of Norm's concern for enhancing the relationship between private and public development in the city and visionary plans and policies in shaping the quality of the city, it is fitting that the first holder of their professorship, effective this month (September), is Professor William L. Porter, head of the Department of Architecture and formerly dean of the School of Architecture and Planning from 1971 to 1981.

Dave Wadleigh has been elected to a three-year term on the Technology Day Committee, and intermittently gets to the Institute as the committee meets to plan the events of the 1990 alumni weekend.

Paul Des Jardins was the only other member of our class whom I saw at the September 23 Alumni Leadership Conference—a full day starting with a 7:00 am breakfast and concluding with a late-afternoon reception. We who spend a couple of weeks sightseeing, hiking, or skiing have to admire the Des Jardins' recent program: six weeks last fall in France, a three-week Elderhostel French Immersion course at the University of Quebec, and two additional weeks in that province, one in Quebec City and one in Montreal.

Do keep your clippings and personal news coming.—Don Severance, secretary, 39 Hampshire Rd., Wellesley Hills, MA 02181; Ed Hadley, assistant secretary, 50 Spofford Rd., Buxford, MA 01921

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Jim Barton, chairman of our 50th reunion committee, wrote to committee members: "Here is our final report card as received from Beth Garvin of the Alumni Office. The lead paragraph in her letter is hard to beat: 'At last the final gift distribution table for your class. There is only one way to respond when you read it—WOW! What incredible results!'"

"There were 388 people on our reunion roster of whom 321 or 82.7 percent made a gift. Those gifts added up to \$5,611,000, an average of \$17,480 per donor. Another probable record is that 22 new life income funds were established—18 by members of the committee! I suppose it is only natural that one of the greatest classes to graduate from MIT should have the greatest gift committee. You were superb. Our work has resulted in receipt of a Presidential Citation from the Alumni Association for our 50th reunion and reunion gift. President Paul Gray and Chairman David Saxon had honored me with a special citation. Its statements, following, are equally applicable to every member of our committee:

"The class of 1939 turned in an outstanding result for the 50th reunion gift. The \$3.9 million goal was ambitious, and you surpassed it with success and achieved over \$5.6 million, a record for recent 50th reunions. We are fortunate to have alumni whose dedication, leadership, and caring support make MIT the special place that it is."

Harold Hindman's business career was briefly outlined in the *Boston Business Journal*. Starting with one basic patent, Harold founded the Instron Corp. and, as its chief executive officer, continues to lead it to unusual major achievements that include generating \$111 million annual sales and \$2.4 million net profit. Harold's company produces instruments and software to evaluate the physical properties and performance of materials, structures, and components.

Richard H. Myers writes from Mansfield, Ohio, "Living the good country life and would welcome hearing from alumni active in amateur radio."

We are saddened by news of the deaths of

three classmates: Norris Dow, Paul Sokoloff, and Edward Yetter.

Bill Gray wrote: "May I volunteer my tribute to a dear friend: Norris Dow, class of 1939. He was my classmate, thesis partner, eventual roommate, and best man at my wedding in 1941. Our classmates might like to know more about his achievements so I've attached a copy of the obituary printed in the April 13, 1989, *Suburban and Wayne* (Pa.) Times:

"... Norris F. Dow, of Radnor, died Wednesday, March 28. Mr. Dow, an inventor, engineer, and independent entrepreneur, is best known for his invention of triaxial fabric, for which he received international recognition.

"Trained as an aeronautical engineer, Mr. Dow conceived of triaxial fabric when he was employed by General Electric's Missile and Space Division. He found conventional "biaxial" fabric stretched on the bias, so he invented the concept of "triaxial" fabric, which has no bias weakness. Triaxial fabric was patented by Mr. Dow in the United States and 15 of the major foreign textile countries of the world.

"Mr. Dow left GE in 1970 as the first employee to have reassigned to him the rights for an invention made while a GE employee, and founded Doweave, Inc., of which he was president and chairman. Doweave was established to develop and manufacture triaxial fabric.

"In 1977 Mr. Dow was awarded the Edward Longstreth medal by the Franklin Institute for his achievement in inventing and developing triaxial fabric. Established in 1890, the Longstreth medal is awarded for "inventions of high order in machines and mechanical processes. . . ."

Paul Sokoloff passed away May 25, 1989, in San Pedro, Calif. Helen Sokoloff wrote: "Everyone, without exception, both colleagues and friends, revered Paul. The world is a better place because of him."

The *Weekly News* of Lyndonville, Vt., reported that Edward W. Yetter died July 8, 1989. Born September 1, 1917, in Nanticoke, Pa., he graduated from MIT, was an electrical engineer, and worked as a consultant to the Dupont Co.—Harold R. Seykota, secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

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50th Reunion

Late in September, the reunion committee and the reunion gift committee met at the Institute. Included was a dinner attended by members of both groups, many of their spouses, and several representatives of the alumni office. Among classmates present were Martin Abkowitz, Dick Babish (reunion chairman), Jim Baird (class president), Edgar Bernard (class treasurer), Sally (Mrs. Bob Bittenbender, honorary reunion co-chairperson), Lee Bloom, John Danforth, Dick Gladstone (class secretary), Joe Jeffers, Tom Kramer, Ty Marcy (gift chairman), Louis Michelson, Dave Morgenthaler, Bill Stern, Karl Pfister, and George Wolfe.

As part of our reunion, June 7-10, 1990, arrangements have been made for a clambake at Seamen's Inn, Mystic, Conn. All the local attractions will be identified, so that small groups can visit the ones they want at their own pace. In Cambridge, we will be honored to lead the academic procession, in our red jackets, for commencement exercises. On Thursday, June 7, we are all invited to President Gray's house for cocktails, then on to dinner at Symphony Hall, followed by the Pops concert. On Friday, June 8, Technology Day lectures and seminars in the morning will be followed by the large alumni luncheon, at which class gifts will be announced. On Friday evening, there will be a class dinner in the Tapestry Room of the Boston Museum of Fine Arts.

Total gifts, as of September 23, 1989, were \$2,911,000, almost 65 percent of our goal of \$4,500,000. Participation is 70.7 percent, with 287 donors. The committee urges all class members to contribute; we want to get the participation rate

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Russel Weinzimmer
Darlene Vanstone
Brian Michaelis

Of Counsel
Alfred R. Johnson, '35
Joseph Zallen, '39

as close to 100 percent as possible and exceed our goal. The future of our country depends on its young people, and what better way is there to help assure a bright future than to make substantial contribution to the Alumni Fund?

Other members of the two committees were not with us for the meetings and dinner, but they are all actively assisting in planning and contacting classmates to encourage their contributions. Reunion committee members are **Paul Bollerman, John Casey, Donald Cole, Charles Edwards, Alvin Gutttag, Russell Haden, Walter Helmreich, Norman Klivans, Richard MacPhaul, Ralph Millett, Franklin Penn, Philip Stoddard, and Barrett Taft**. Other gift committee members are **Paul Dickson, Bruce Duffett, Sam Goldblith, Bill Hagenbuch, Walter Helmreich, Amos Joel, George Kaneb, Norm Klivans, Frank Libman, Marshall McCuen, Phelps Walker, Garrett Wright, Ed Wallace, and Al Wu**. Some members are real eager beavers and are serving on both committees.

Eleanor (Mrs. Albert E.) Norris sends a note telling of her educational tour last March, conducted by Yale University, to the Galapagos Islands, and back through the Panama Canal. A Yale professor lectured on Darwin and evolution and a Harvard professor talked about South American Indian culture. She found the animals unusual and fearless. A wet landing was made by Zodiacs, and she swam with the sea lions and patted the great land turtles, but did not ride them.

A recent Alumni Leadership Conference was attended by three of our classmates: **Jim Baird**, class president, member of the reunion and gift committees, and a solicitor for the Alumni Fund spring telethon; **Ty Marcy**, Corporate Development Committee member, reunion gifts committee chairman, Club of Cape Cod president, director and vice-president of programs; and **Michael Biancardi**, Educational Council member. Mike was also honored as a recipient of the George B. Morgan, '20, Award.

How many of you saw the letter to the editor from **Norm Klivans** in the October-November issue of *Modern Maturity*? It dealt with hiring persons over 50 and the advantages to firms of making use of their abilities. Norm notes that his firm places interim or temporary managers and executives, mostly over 50, in operating positions within a company. He points out that these people are "job hardened, experienced, dependable, and necessary."

Sadly, we must report the death of **James Brewster III**, of Vero Beach, Fla., and Wilton, Conn., on July 21, 1989. He received his S.B. in aeronautical engineering. He had retired from Sylvania/GTE as vice-president of sales. . . . **Rafael J. Martinez** of Forrest Hill St., G13, Garden Hills, Guaynabo, PR 00657, died April 5, 1989. He is survived by his wife, Julia. The class extends its sympathies to the families of these classmates.

Joseph B. Wiley, Jr., of Bedminster, N.J., reports the passing of **John Joseph** of Hasbrouck Heights, N.J. According to the local newspaper, John was a staunch political activist, who strongly opposed the Vietnam War. As a Peace Democrat, he sought the Democratic nomination for Congress but was unsuccessful. He was a toy manufacturer, but he refused to ship his products to Mississippi during that state's battle against integration in its schools. He was active in the Civil Liberties Union, the Martin Luther King foundation, Amnesty International, and Americans for Democratic Action. His wife has suggested that anyone wishing to make a donation in his memory may make it to the Richard P. Feynman (1939) Scholarship Fund, MIT, c/o Beth Garvin, Alumni Association, Bldg. 10-140, Cambridge, MA 02139. Our heartfelt sympathies go out to John's family.

Keep the news coming, and especially keep the gifts coming to make **Ty Marcy's** job a most rewarding endeavor.—**Richard E. Gladstone**, secretary, 1208 Greendale Ave., Needham, MA 02192

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It is not surprising that a number of classmates are interested in boats, shells, cruisers, submarines, etc. In the last class column, I quoted from a great letter from **Quentin R. Wald**. This is the second installment; Quentin sailed in a transatlantic race from Las Palmas to Barbados. He writes: "Each day we ran the engine with propeller disengaged for an hour to charge our batteries. On the sixth day, I was unable to turn the engine over. I thought that seawater had gotten into the cylinders. We immediately shut down the electrical system in order to save our meager remaining battery power for the approach to Barbados. I got my old sextant out of its box and brushed up on my celestial navigation. It turned out to be a pleasure to revert to the old self-reliant way of navigation. I got a morning sun sight each day and a meridian altitude at local noon, which, with the Walker log, gave me a running fix each noon. I programmed my pocket calculator with a sight reduction formula, which made the whole procedure very easy. As we sailed southwest for days, the sea grew steadily warmer and we shed most of our clothing, even at night. Below latitude 20°N, we saw many flying fish, often finding a few on deck in the morning. We had a period of five days during which we were becalmed. One evening in particular was magically beautiful with subtle colors on a perfectly still, eerily silent sea, the only clouds distant marching rows of cumulus extending over the rim of the earth. On the seventh day, the northeast breeze strengthened and we were at last in the true trade winds. The deep blue rollers built up, the stern lifting to each one as we rushed down its face. We crossed the finish line at Barbados 23 days and five hours, some 2,700 miles from Las Palmas. We finished about in the middle of our class, letting the wind vane do the steering and never pressing *Anaximander*. Some days later, we sailed for Bequia, crossing at last the track of my doughty old ketch *Fore and Aft* of 35 years earlier."

Raymond C. Foster reports the death of his wife, Anne H. Foster, of a brain tumor. Anne was an avid skier and won a gold medal for combined alpine skiing in the 50-and-up category in 1975. Anne was a trustee of the Arthur D. Little Advanced Management Institute and of the Tabor Academy. She was also a director of the Wang Center for the Performing Arts and of many other organizations. She is survived by three daughters, two sons, and six grandchildren. Raymond, please let your classmates know what you are up to.

Charles J. Muller has had his architectural firm in the north Texas area for 43 years, after spending five years in the military service.—**Joseph E. Dietzgen**, secretary, Box 790, Cotuit, MA 02635

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Please send news to your class secretary.—**L. Kenneth Rosett**, secretary, 191 Albemarle Rd., White Plains, NY 10605

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I must sadly report the death last July of **John J. McNulty, Jr.** (Course VII) in Carmel, N.Y. After graduation from MIT, John served as a Marine officer in the South Pacific. His architectural career included the design and construction supervision of many stately homes in the Carmel/Brewster area. He is survived by a number of cousins in New York, Florida, and the Midwest.

Several classmates attended the Alumni Leadership Conference in Cambridge last September 23. In this group were **Burt Angell, Kemp Maples, Chris Matthew, Jim McDonough, Stan Proctor**, and your secretary. Collectively, they represented about 200 years of service to the Alumni Association

as fund raisers, educational counsellors, club officers, class officers, Association officers, and Corporation members. Their efforts have been recognized by a Lobdell Award, a Morgan Award, and three Bronze Beavers. I was proud to be in their distinguished company.

Next month, I'll report on the Great Southwest, etc. gathering in Albuquerque. Stay tuned.—**Bob Rorschach**, secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

On September 23, 1989, the Alumni Leadership Conference was held at the Institute. This year's event brings together the loyal MIT alumni/ae who work so hard throughout the year in fund raising and all the other areas that enable MIT to remain the leading engineering and scientific institution. It was attended by **Frank Carroll, Louis Demarkles, Alfred Picardi, Melissa Teixeira, John Wald, and Stanley Warshaw**. Our class president, **Ed Eaton, Jr.**, was awarded the Henry B. Kane, '24 Award for recognition of exceptional service and accomplishments in the area of fund raising for the Institute. It was an award well deserved for the more than 20 years Ed has put into this task.

Al Picardi, our class agent, is hard at work preparing plans for ways to raise money for our 50-year class gift in 1994. You will undoubtedly hear from Al from time to time. Pay heed.—**Andrew Corry**, secretary, P.O. Box 310, W. Hyannisport, MA 02672; **Lou Demarkles**, secretary, 77 Circuit Ave., Hyannis, MA 02601

45

45th Reunion

Happy New Year and a formal welcome to our 45th reunion year. Yes, 1945 plus 45 equals 1990 even in this era when the half-life of an engineer is somewhat less than ten years. If you are still on our or the Institute's mailing list, you know by now that we shall be reveling at New Seabury in Mashpee on the western end of Cape Cod the weekend of June 8-10 following more formal activities at the Institute on June 8-9. Now that we are at mid-life (!) we should have both the time and inclination to rejoice amongst ancient friends and associates. Unfortunately we have no detail, as **Charlie Hart's** reunion committee meeting is about a fortnight away.

Let me share with you a heartwarming note from the husband of **Natalie Wilder Jeannette**, who died on July 1 following a long bout with diabetes. "Natalie was very proud to have been a graduate of MIT, and she imbued her eight children with the importance of education. All are college graduates and hold good responsible jobs as a result. If her MIT degree did nothing more than that, her degree has been a resounding success." A great tribute to both Natalie and the Institute. Theodore L. Jeannette, Natalie's widower, lives at R.D. 2, Box 190, Zelienople, PA 16063.

Tom McNamara gives us a report from last year's Pops attendees. Jan and **Charlie Patterson** (particularly the latter) are still majoring in golf. They vacation on a different Caribbean island each year. Free time is spent visiting the two grandchildren. . . . **Chris Boland** says he is thinking about slowing down; occasionally he takes a late train into New York and an early train home. Meanwhile, Jean continues to work part time as a travel agent. Their China trip planned for 1990 may not happen. . . . **Bob Maglathin** is doing private consulting in the radar field since retiring from Raytheon. Bob and Ann hopefully had a good trip to Alaska, which was to include friends in Valdez. . . . **Dee and Frank Gallagher's** youngest graduated from high school last spring. Frank continues to windsurf in the Dorchester Bay Castle Island area on a daily basis. . . . **George Berman**, who continues as chairman of Unirode, was married to lovely Jean last April.

Jim Pickel, a teacher at Woodward School for Girls in Quincy, is viewed highly by his students, as they dedicated their 1989 yearbook to him. . . . **Mary (Mrs. David) Trageser** is still active at the Wayland Library. We are all anxious to learn about her ElderHostel experience in England with **Mary (Mrs. James) Hoaglund** this past fall. **Marie and Gerry Quinnan** have moved after all these years from Needham to El Paso to be closer to grandchildren.

Reporter **Tom McNamara** continues to lecture and consult in information systems since his retirement from Honeywell, while **Louise** is an adjunct professor in office automation at Massachusetts Community College. Trips continue to abound—Alaska in 1988, the Canadian Pacific Dome train across Canada in 1989, and China, hopefully, in 1990.—**Clinton H. Springer**, secretary, P.O. Box 288, New Castle, NH 03854

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Please send news to your class secretary.—**James C. Ray**, secretary, 2520 S. Ivanhoe Place, Denver, CO 80222

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Please send news to your class secretary.—**Robert E. McBride**, secretary, 1070 Pilgrim Parkway, Elm Grove, WI 53122

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The Alumni Leadership Conference was held on campus last September to provide an exchange between the 1,700 educational counselors, 2,800 other volunteer leaders (fund, class, club, etc.), and the Institute. **George Clifford**, **Harold Ottobri**, **Jack Walch**, **Harry Jones**, **Bob Ormiston**, **Bob Wofsey**, **Peter Saint Germain**, and **Marty Billett** had dinner together, the night before the conference. We ate at Networks, a new restaurant in the Stratton Student Center, which has been reconstructed. The Harvard Coop has moved to Main Street. In addition, **Victor Ransom**, **Jay Salz**, **Bill Bangser**, and **Peter Hand**, all of whom are educational counselors, attended the conference. **Peter Hand** was awarded the Bronze Beaver in 1977 for his work as an educational counselor in the central Florida area. **Backmon Wong**, **Bob Sandman**, and **Paul Anderson** also attended the conference.

During the conference luncheon, **George Clifford** was awarded the Harold E. Lobdell, '17, Award. **George** was recognized for his service as class treasurer, reunion chairman, and class president. As class president during the five years before our 40th reunion, he provided important leadership, which resulted in our class making the largest 40th reunion gift in MIT's history.

Marty Billett (that is me) was awarded the Bronze Beaver. I quote from the citation: "Constitutionally incapable of saying no to any request for assistance to MIT, **Marty** unfailingly does whatever is necessary to complete the job with deep devotion and a distinction and thoroughness that are his personal stamp."

During the last Alumni Fund Year, several geographical areas conducted a visit program based on asking solicitors to make a personal visit to other alumni to solicit their gift to the Alumni Fund. The following classmates were chairman in their respective areas: **Frank Iskra**, Cincinnati; **Jim Frevert**, Palm Beach; and **Marty Billett**, Providence.

Bob Ormiston started teaching at a local college after he retired from AT&T. In addition, he is changing the heating system in his home. The electric heat is being replaced with a gas-fired boiler and forced hot water circulation to distribute the heat. He found a company that makes a boiler and gas-fired burner combination that is 90 percent efficient. He went to Heat Maker's plant

in Randolph, Mass., for a one-day training session to instruct installers and setup personnel. He is soldering the one-inch copper pipe needed for distributing the hot water. In anticipation of a few leaks, he uses more unions than is common.

Peter Saint Germain and his wife, **Janet**, and their daughter made a sightseeing trip to Alaska, starting in Seattle. First, they took the hydrofoil to Victoria where they visited the Bouchard Gardens. Then they went to Vancouver where they boarded a 750-foot long vessel with 400 passengers. Each day the ship spent time in a port while the passengers explored the surrounding area. At night the ship scooted along to the next stopping point. In Alaska the ship came within a few hundred feet of glaciers that descended to the water's edge. Whenever the glacier dropped pieces in the ocean, the visitors heard a mighty roar. A bow thruster provided maneuverability allowing the ship to stay clear of the icebergs.

Bob Wofsey has retired again. This time after four years with Ward Howell International. Before retiring, he hired his replacement and made recommendations for purchase of additional computers to install a new accounting system. After retiring, **Bob** and **Marcia** visited old friends in the Colorado Rockies.

Harry Jones and his wife, **Ann**, have four cars, and two of the cars are operable. The other cars allow **Harry** to continue his hands-on approach making repairs and improvements. **Harry** is an independent broker arranging mergers and acquisitions. He and **Bill Zimmerman** have evaluated several possible deals. **Harry** continues his numerous activities in support of the MIT Alumni Association. He is an active educational counselor in northern New Jersey in addition to working with the MIT Club. **Harry** and **Ann's** son, **Craig**, recently resigned from Drexel Burnham's junk bond department. **Craig** has joined Fidelity funds. **Harry** spent an evening at my home, and we looked at pictures from our 5th reunion at the Mayflower in Plymouth. Between us, we identified most but not all of the classmates in the pictures.

The editors of *Fortune* magazine may be reading our class notes. Their September issue featured a story of how the managers of Harley Davidson, who bought the company, pulled off one of America's most celebrated turnarounds. As reported in the August issue of these notes, **Vaughn Beals** led the group of 12 other managers who increased sales and have achieved a market share double that of their nearest competitor. Profits that did not exist in 1982 were \$26.9 million recently, and sales have increased four times since 1982 to today's level of \$810 million (*Fortune* #398). **Vaughn** is quoted as saying about 1981, "We were being wiped out by the Japanese because they were better managers. It wasn't robotics, or culture, or morning calisthenics and company songs—it was professional managers who understood their business and paid attention to detail."

Jean and **Milton Slade** are busy planning another wedding. This time their daughter, **Martha**, will be married in February in Wrentham, Mass.

Victor Dawson married his wife, **Marguerite**, three days after his graduation from MIT. They have five daughters and 15 grandchildren. Since graduation, he has earned an MS from Harvard, ME from Caltech, and PhD from University of Maryland, all in mechanical engineering. He retired after 31 years at the Naval Ordnance Lab (now the Naval Surface Weapon Center) in Silver Spring, Md. He was a department head when he retired. Presently, he is a full-time senior analyst at the Center for Naval Analyses, a non-profit federally funded research center. During his career, he did engineering and was extremely happy with the path that he chose. He feels that he owes a great deal to MIT and the other fine universities that he attended.

Irving Kagan has only worked for one company since 1948 and is currently CEO of Penobscot Shoe Co. He is a trustee and treasurer of the

Maine Maritime Academy in Castine (where great sailing is available on the Maine coast). He also serves the U.S. Ski Association as a director and officer, with the interesting assignment of leading the new discipline of freestyle. Freestyle made its debut as a demonstration sport at the Winter Olympic Games in Calgary. **Irving** attends international meetings and hopes to elevate freestyle to a full-fledged Olympic sport in the near future. Watch for ballet, mogul, and aerial performances on skis.

Robert Lambert died last year. He had been living in N. Plainfield, N.J. On behalf of our classmates, I extend our sympathy to his wife, **Marion**.—**Marty Billett**, secretary and president, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

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Most of us reach, or will reach, the age of 65 with a lot of mileage left in us. And most of us recoil at the thought of rocking chairs. One such person, according to a feature article in the July 19, 1989, issue of the *Philadelphia Inquirer*, is **Lewis Roosa** of Paoli, Pa.

A few months before retiring at age 64 from GE Aerospace in King of Prussia, Pa., **Lew** enrolled in a course sponsored by GE and Drexel University, in which he learned how to become a physics teacher. After taking five courses over a period of 18 months, **Lew** went out to do field teaching, a requirement for state certification. **Lew** met the requirement by teaching at Central High School in Philadelphia. In one classroom session, according to the *Inquirer*, **Lew** was "explaining the Pythagorean theorem. Although the class at first wasn't too enthusiastic about learning that in a right triangle the hypotenuse squared is equal to the sum of the squares of the other two sides, **Roosa** soon had the students on their feet, acting out the concept. The class applauded **Roosa** at the end of the session." Courses such as **Lew** has just completed are becoming available around the country, having been launched by the National Executive Service Corps, an association of retired executives who wish to remain active.

Another insight into **Lew's** supplies of energy was provided at the Leadership Conference held at MIT last September 23. **Tom Tooey**, our class president, and I were sitting together during the awards ceremonies when we heard **Lew Roosa's** name being read by **Harris Weinstein**, '56, president of the Alumni Association. **Harris** was reading from a list of those who had been awarded the Henry B. Kane Award "in recognition of exceptional service and accomplishment in fundraising for the Institute." My own recollection of **Lew** is that of an enthusiastic trombone player in the Tech Show.

A slip of paper before me announces that effective today (October 1), **William A. Black, Jr.** of Fort Wayne, Ind. is retiring as president of the Indiana Michigan Electric Co. (a subsidiary of American Electric Power Co.). **Mr. Black** earned three degrees while at the Institute: VIA, SB and SM; and XVA, SM. It is disappointing that my piece of paper is so cryptic since people of prominence, like **Mr. Black**, have invariably led meritorious and newsworthy lives of which it would be nice to know the details.

John Cambridge Miller, Jack to most of us, died August 12, 1989. **Harry Lambe**, who had been Jack's close friend since they took chemical engineering together, provided the following information: Upon graduation, Jack joined a marketing group for Formica Industrial Products in New England but rather soon became a key man in the Formica Chicago office. From there he went to Formica headquarters in Cincinnati as a marketing executive. With American Cyanamid's increased involvement in Formica, Jack went to their headquarters in Wayne, N.J. John leaves his wife **Munya** in North Easton, Mass., his mother in Grafton, Vt., daughter **Lisa** in Sidney, Australia, and son **John**, who lives on the North Shore

in Massachusetts.

Anatol "Andy" W. Bigus died July 24, 1989. Andy was an investment adviser with an office in Brookline, Mass. I saw him frequently at MIT functions. He leaves two brothers, Col. Walter T. Bigus of Sacramento, Calif., and Thaddeus A. Bigus whose address is: Section Manager's Office, United States Naval Air Station, Fleet Post Office, NY 09523; and a sister, Mrs. Charlotte M. McCormack of Jersey City, N.J.—**Fletcher Eaton**, secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

50 40th Reunion

Please send news to your class secretary.—**John T. McKenna, Jr.**, secretary, 9 Hawthorne Place, Apt. 10H, Boston, MA 02114

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I received only one news item for this month's issue. . . . After having served 24 years with A.I.D. in various Latin American countries and in Washington, **William G. Rhoads** has retired. He writes that his final four years in Lima, Peru, were often frustrating ones and he is grateful to once again be home.—**Martin N. Greenfield**, secretary, 25 Darrell Dr., Randolph, MA 02368

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Our class has reached the age for major transitions, as you can see from this month's news: two promotions, two retirements, and—sad to say—one death. **Arnie G. Kramer**, has been promoted to principal engineer at Mitre Corp., where he has worked since 1979. Arnie's specialty is microwave electronics. The other promotion goes to **Frank Spinelli**, who is now president of Suisman & Blumenthal, a firm that recycles metal scrap. He has been with the company since 1974.

Samuel Goodwin retired in June 1988 from the Rochester, N.Y., city school district. He had been Science Department chairman at East High School and had served the district for 29 years. He now makes music with three groups, playing bass viol and cello. . . . **Marty Fink** writes that he took early retirement last July from Norden Systems, where he had been an advanced systems engineer. He is starting a new career as a consultant in aerodynamics, aeroacoustics, and missile and weapon systems. He and his wife have three sons and recently celebrated their 37th wedding anniversary. Marty lives in Fairfield, Conn.

I am sorry to report that **Charles Stockdale**, of South Yarmouth, Mass., died June 9, 1989. For 16 years until his retirement in 1986, he owned and operated the Cape Cod Salt Water Taffy Co. He is survived by his wife Susan, a daughter, two sons, and three grandchildren, as well as his mother, stepfather, and a brother.—**Richard F. Lacey**, secretary, 2340 Cowper St., Palo Alto, CA 94301

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Some results of our class's efforts in support of the Alumni Fund: the total FY89 donations to the Fund from all classes was \$144 million and the overall participation averaged 49 percent. The Class of '53 donated \$150,551 for an average of \$53 with almost 50 percent, or 304 out of 604 active Alumni/ae, contributing. That does not include amounts over \$50,000 or pledges not yet collected.

It is interesting to note that the class of '53 has roughly \$1.9 million of pledges due in, as of July 15, 1989. I'd say that is quite good. However, I expect that we all will be able to increase our contributions when our children complete college, as my last one did this September.

Not only did my youngest son, Joel, complete college in September 1989, but I celebrated the wedding of my youngest daughter, Eileen, in September also. I am now free of responsibilities for my children and can relax and enjoy watching my seven grandchildren grow and develop. I don't think my offspring (seven) have stopped as yet, because my second son, David (MIT '78), and his wife are expecting their second child in November. Now that I have followed through with my threat to tell you about my family goings-on, maybe you all will send me some items to publish.

I did receive one item about **Michael J. Rabins**. He is currently a professor and head of Texas A&M University's Department of Mechanical Engineering. He was elected a senior member of IEEE. This highest level in the organization recognizes his extensive experience and professional stature.

Rabins joined Texas A&M in 1987, coming from Wayne State University where he was associate head of engineering. In addition to an MIT undergraduate degree, Rabins has a master's from Carnegie Institute of Technology and a doctorate from the University of Wisconsin, all in mechanical engineering. He specializes in design, systems, and control.

And finally, I must turn to the tough part of this job. It saddens me to report that **Alan Friedman** passed away on June 27, 1988. He lived in Wilmington, Mass., and is survived by his son Henry.

I have also been advised of the passing of **Edward A. Flinn** on August 13, 1989. Flinn was chief of the Solid Earth Sciences Program of the National Aeronautical and Space Administration. He died of cancer in Arlington, Va. After graduating from MIT, he received a doctorate in geophysics at the California Institute of Technology. He also studied at the Australian National University in Canberra on a Fulbright Scholarship. He later worked on underground nuclear test detection in Alexandria, Va. From 1981 to 1984, Flinn was secretary general of the Inter-Union Commission on the Lithosphere and the Inter-Commission of the International Council of Scientific Unions.

He was a former editor of the *Journal of Geophysical Research* and had published more than 40 articles in scientific journals. In May, he was elected a fellow of the American Geophysical Union. Flinn is survived by his wife, Jane, a daughter, Susan, and a sister, Elizabeth.

Again, I'd appreciate hearing from class members and would like to appeal for some ideas for a "between-the-reunion" get-together. Drop a note to me at the address below.—**Gilbert D. Gardner**, secretary, 1200 Trinity Dr., Alexandria, VA 22314, (703) 461-0331

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Please send news to your class secretary.—**Edwin G. Eigel, Jr.**, secretary, 33 Pepperbush Lane, Fairfield, CT 06430

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Lots of mail from the 122 (up from last reported count of 108) of you who responded to the mailing for the 35th reunion of the illustrious class of '55. Joe and I are of course delighted with the response, and with the help of the excellent committee that is planning and organizing this event, we are all looking forward to a wonderful time. More about the reunion in class mailings—on with the other news.

Gary Brooks reports that the turnaround consulting-crisis management practice with his partner in Allomet Partners continues to go well, in part thanks to leveraged buyouts in an increasingly difficult business environment. His family is enjoying life in New York City after 15 years in western Massachusetts. . . . **Richard I. Bergman**

was elected to his second (and last—says he!) term as president of The MIT Club of Princeton. On the personal side, his daughters, Susan and Deborah, are both married, and granddaughter Cheryl (Susan's daughter), just turned 2.

Stanley Barriger continues to be active in the international railroad business from his home base in New Hampshire. Baby Amy Suzanne arrived May 11, 1989, to join her brother, Mark Stanley, age 3. Stanley has been doing much foreign railroad consulting; over one recent six-month period he was in Taiwan, Egypt, and Korea for railroad engineering projects. He also has a travel agency in Claremont. . . . **Paul Attridge's** daughter Joanne graduated from Wellesley College as an astronomy major. She is staying on at Wellesley for another year as a teaching assistant in the Computer Science Department and as a laboratory assistant at the observatory while she prepares for graduate school next year.

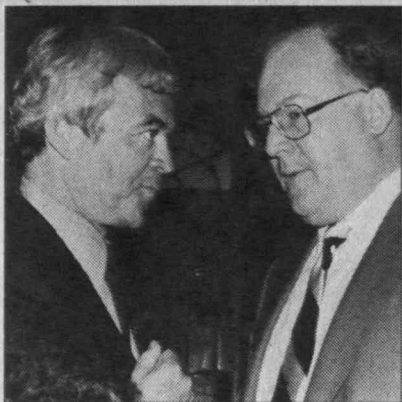
H. Rowe Austin is active in scouting and served as a Scoutmaster at the 1989 National Boy Scout Jamboree at Fort A.P. Hill, Va., in August 1989. . . . **Philip N. Eisner** helped develop a new consulting company, Berkowitz & Associates. It specializes in strategic planning and decision and risk analysis for businesses in the New York-New Jersey area. This is a change from physics research, but he is enjoying it immensely! . . . **John M. Farmer** is enjoying his return to Vermont politics as state senator for Lamoille County, which includes Stowe and Smuggler's Notch Ski areas. A second grandson arrived recently.

Each month we learn of more retirees and career changers from our class. . . . **Max Musgrove** reports he has retired to a hilltop outside of Mayaguez, Puerto Rico, and is scuba diving in Cozumel, Mexico after 33 years with Boeing Aerospace in Seattle, Wash. . . . **Bert V. Borngesser III** has retired from IBM after 30 years service and now has his own systems/applications business. . . . The third retiree reporting this month is **Vladimir Charnyshov**, who sent in his first class notes in 35 years! He retired last November and has more time to write now. He worked for Transiron, a successful semiconductor manufacturer in Wakefield, Mass., for almost nine years, and then joined IBM in 1963, where he worked for the first six years in East Fishkill. In 1970 he transferred to IBM's Silicon Junction (in Essex Junction, Vt.) as the site quality manager and was soon running a 1 Kbit chip line, 64 Kbit, and in 1986 a whole 1 Megabit! His last assignment was managing packaging and test for the site (both manufacturing and development, some 1,700 people), not the biggest job in his career but he says it felt like a proper place to stop working regularly. He is now consulting for IBM on a number of interesting projects (like a 64 Megabit chip) and trying to do the same for other companies. Along the way he married (now 32 years), had five children—four have finished college and two of them are married and have produced four grandchildren. He and Luisa are looking forward to seeing us all again next year. It should be a fun reunion.

On that note we will close for now and save some of your notes for later issues.—co-secretaries: **Robert P. Greene**, 100 Memorial Dr., 11-2A, Cambridge, MA 02142; **DuWayne J. Peterson, Jr.**, 201 E. 79th St., New York, NY 10021

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Gideon Gartner is to stay on as chairman of the Gartner Group through 1991 and as a part-time consultant until 1995, possibly becoming an analyst again after that. The Gartner Group is a top computer-industry think tank in economy with clients that include 49 of the top 50 Fortune 500, with an annual revenue of about \$60 million and increasing by about 50 percent per year. The Gartner Group was acquired by Saatchi & Saatchi of Great Britain, the world's largest advertising agency, for \$90 million, a small price for Gideon's "wisdom business." Previously he worked for Op-



Gideon Gartner (left) and Bill Grinker at their 30th reunion.

penheimer & Co. and IBM, after staying on to obtain his master's at the Sloan School, having decided he really did not want to become an engineer. The *International Investor* magazine rated Gideon as the top individual securities analyst in the technology field between 1972 and 1978. Possibly one of his greatest ambitions has come true: to have been voted a vice-president of our class.

We are still looking for feedback from mini-reunions. **Klaus Kubierschky** and **Larry Goldberg** led such an event at an October MIT football game; a summary should be in the next class notes. . . . Have a good year.—**George H. Brattin**, co-secretary, 39 Bartlet St., Andover, MA 01810, (508) 470-2730; **Irwin Gross**, co-secretary, Sweets McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181

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Please send news to your class secretary.—**John Christian**, secretary, 23 Fredana Rd., Waban, MA 02168

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Please send news to your class secretary.—**Michael E. Brose**, secretary, 841 Magdeline Dr., Madison, WI 53704

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Please send news to your class secretary.—**Allan S. Bufford**, secretary, Office of the Treasurer, MIT, 238 Main St., Suite 200, Cambridge, MA 02142

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30th Reunion

We have a Nobel laureate in our class—the Royal Swedish Academy of Sciences has awarded this year's prize in chemistry to **Sidney Altman** for his work describing the surprising properties of the genetic material RNA. The Academy noted that "this discovery, which came as a complete surprise to scientists, concerns fundamental aspects of the molecular basis of life. Many chapters in our textbooks will have to be rewritten." Sid, who is on the faculty of the Yale University Biology Department, shared the \$469,000 prize with Thomas Cech. They showed that RNA does not need enzymes to go into action but can sometimes process the necessary genetic information by itself. Their discovery suggested that RNA was the original life-form with both the knowledge and power to reproduce itself. This discovery holds promises for the treatment of viral diseases, perhaps leading to the cures of

everything from the common cold to AIDS. Our heartiest congratulations to you, Sid.

Our 30th reunion chairman, **Jorge Rodriguez**, and his committee have been hard at work lining up a not-to-be-missed slate of activities for June 7-10. As of this writing, the long weekend begins with MIT Night at the Pops on the 7th, Technology Day on the 8th, followed by Friday evening, Saturday, and Sunday at a resort on Cape Cod. I hope that you are planning to join your class for what Jorge guarantees will be a memorable get-together. Class president, **Tim Hart**, tells me he will be there with "Hammus et Eggus" T-shirts and mugs for those of us who missed them at our 25th.

From Freemont, Calif., **Burnell West** writes: "Migrated from physics to instrumentation to systems to ATE, and I am currently a technologist at Schlumberger." Burnell's older daughter, Misty Lynn, is at Princeton, and younger daughter, Laurie is a national-class gymnast.

Ted Kraver, who lives in Phoenix, Ariz., has turned to politics in a novel way, developing a new political party. The Dynamic Balance Party, says Ted, "is based on the inclusion of the planner/implementors and the realistic visionaries. Governance must address the needs of the information age, the very long-range world crises, and depart from our industrial age model and mindset." We are up to a whopping 150 members," writes Ted.

The auto section of a recent *Washington Times* featured **Jerry Kaiz** and his 1960 Plymouth Fury convertible, which he is planning to drive to the 30th reunion. Jerry got his first 1960 Plymouth, a two-door hard top, as a graduation gift, but that car was traded away many years ago. He found his tail-finned beauty of a convertible in 1985 (with 54,000 original miles) and has been restoring it ever since. No tape deck in this car—instead it comes with a dashboard mounted, 45 rpm record player. At the reunion, Jerry promises a spin to all who want a ride in a "real car."

I had the pleasure of seeing classmates **Calvin Koonce** and **Pat Coady** at a September 1989 MIT-sponsored dinner in Washington honoring White House chief of staff, John Sununu, '61. Calvin is president of his own securities firm, and President Bush recently has appointed Pat as the U.S. executive director of the World Bank.

Sadly, I report the death of **Terry Welch**. Terry of Austin, Tex., died of cancer in November 1988. Terry's career included teaching at the University of Texas, research with Sperry, and senior management with Digital Equipment Corp. At the time of his death, Terry was vice-president of research for International Software Systems, Inc. Our sympathy goes to Terry's wife, Raylene, and their three children.—**Frank A. Tapparo**, secretary and class agent, 15 S. Montague St., Arlington, VA 22204

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Welcome to the nineties! It's time to begin thinking about our 30th reunion in 1991. It's a depressing thought that 1991 will mark 30 years. As we get older and our kids begin to make a life of their own, I suppose everyone is getting more philosophical about the future. I look forward to hearing your ideas now that you are five years wiser than our last reunion.

Bob Pease writes to point out that his long-running series on analog circuit troubleshooting is in *EDN* magazine (and not *EON* as was printed in the August/September class notes column). Sorry. The latest episode is called "Active-Component Problems Yield to Painstaking Probing."

Mark Littmann is another prominent writer. Mark won the American Institute of Physics science writing award last year. The prize, given for a book entitled *Planets Beyond*, included \$3,000 and an engraved Windsor chair. The book is about Uranus, Neptune, and Pluto, with vignettes

of some of the people involved in their study. A paperback updated to include the latest word from *Voyager 2* is in the works. Mark is president of Starmaster Corp., an educational publishing firm. After leaving MIT, Mark went to Northwestern and got a PhD in philosophy in 1966.

I'm saddened to report the death of **Bob Weirich** from a heart attack while swimming in Rockville, Md., last May. He was a well-known civic activist who worked for historic preservation in Rockville and for the Rockville Traffic Commission. Bob was to have been married last August to Carol Kurtz. He had two children, Kurt and Erica, from a previous marriage.—**Andrew Braun**, secretary, 464 Heath St., Chestnut Hill, MA 02167

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Course VI classmate, **Larry Stine**, has been promoted to principal engineer in Division W30 of MITRE. Larry joined MITRE in 1963 after obtaining his MS in electrical engineering from Stanford University. He has broad experience in diverse communications technologies, including satellite, terrestrial radio, and cable-based systems. He is currently working with the Defense Communications Agency and has supported projects for NASA, the U.S. Air Force, FCC, and the Executive Office of the President. Recently, Larry has helped plan common-user architectures, such as the Worldwide Digital System Architecture, and emerging systems, such as the Integrated Services Digital Network.

We are saddened to learn of the passing of Mrs. Ruth Ippen, mother of classmate and MIT professor of electrical engineering, **Erich P. Ippen**. Mrs. Ippen was also the widow of the late Institute Professor Arthur T. Ippen of the Department of Civil Engineering. She was quite active as a conservationist and community leader in the Belmont suburb of Boston. Mrs. Ippen will be remembered as a champion of public green spaces and community landscaping. She was a gracious hostess for hundreds of her husband's professional associates, MIT students, and their families that together comprised an international network of friends that shared similar concerns about the environment. A Ruth Ippen Garden will be established in her memory at MIT, and contributions may be sent to the Ruth Ippen Memorial Fund, MIT Treasurer's Office, Room 4-113, Cambridge, MA 02139.

Robert J. Elliott has been appointed vice-president, Worldwide Business and Technical Systems, for Bull HN Information Systems, Inc., of Billerica, Mass. He joined the Bull organization from Apollo Computer, Inc., where he was vice-president, Information Systems and Resources, and led the development and installation of systems that supported the eight-fold growth of that company. At Bull, Bob will be responsible for the strategic planning and management of business and technical information systems in 28 countries and will integrate the requirements and solutions with Bull S.A. in France to optimize investments in resources. We are pleased to learn that yet another of our classmates is providing leadership for the growth of worldwide information technology and that's "Know Bull."

If you have any interesting news or just want to tell your classmates about a personal revelation that might be of interest to them, please write: **Hank McCarl**, secretary, P.O. Box 352, Birmingham, AL 35201-0352

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It's the usual summer doldrums again. Yes, I know, you are reading this in the dead of winter. I am writing in late September, and your classmates haven't yet gotten back in the swing of writing. . . hint, hint. I did get a newsy letter, however, from **John Wasserlein**. On his 48th birthday, July 25, the board of Boise Cascade made John a senior vice-president. He also con-



The auto section of a recent Washington Times featured Jerry Kaiz, '60, and his 1960 Plymouth Fury convertible, which he is planning to drive to his 30th reunion. Kaiz got his first 1960 Plymouth,

a two-door hard top, as a graduation gift, but that car was traded away many years ago. He found his tail-finned beauty of a convertible in 1985 (with 54,000 original miles) and has been restoring it

ever since. No tape deck in this car—instead it comes with a dashboard-mounted 45-rpm record player. At the reunion, Jerry promises a spin to all who want a ride in a "real car."

tinues as general manager of the Publishing and Packaging Paper Division. That division has operations in two states and Canada, including about four million acres of timberland and eight hydroelectric stations. His additional duties involve strategy formulation and capital spending allocations, membership on several top-level committees, and attendance at many board meetings. Congratulations, John, on a very impressive achievement. But get this: he still has time and energy to take care of his 14-year-old daughter, who gets straight As and is considering MIT and Harvard.

John Wawrzonek was one of six photographers "whose work represents a new vision in the nature photography tradition" in September and October at the Wrubel Gallery in Concord, Mass.

A press release from the American Statistical Association tells us that they have elected **Bill Barnett** a fellow. Bill is a professor of economics at UTexas/Austin. The ASA, 150 years old in 1989, was founded in Boston. Early members included Florence Nightingale, Alexander Graham Bell (who of course did much of his development work in MIT laboratories), Herman Hollerith, Andrew Carnegie, and Martin Van Buren. This is a special honor for Bill.

OK, now turn on your word processor, or pick up your phone and send me some news.—Phil

Marcus, secretary, 3410 Orange Grove Ct., Ellicott City, MD 21043, (301) 750-0184

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Welcome to a new decade! As I write, the leaves are turning in northern New England, and we've started shopping for a four-wheel-drive vehicle in preparation for winter. We're ready to move from New Hampshire to our "permanent" home in Norwich, Vt. (across the river from Hanover/Dartmouth—see new address at the end). Moving from a state whose motto is "Live Free or Die" to one whose motto is "Freedom and Unity" is too mind-boggling to contemplate.

We enjoyed a delightful visit from Linda and **George Piotrowski** and their sons Eric and Mark. The Piotrowskis were in New England college-shopping for Mark. This past spring George was a member of a People-to-People delegation studying automotive medicine and safety in Europe. The group consisted mainly of trauma surgeons, but included several experts in accident reconstruction and injury causation (George's specialty). The two-week tour included visits to auto manufacturers, traffic research laboratories, and trauma centers. The group saw some crash tests, heard the Budapest Chamber Orchestra,

and enjoyed many culinary delights including reindeer.

From Irvine, Calif., **Joel Kalman** writes that he is with Gateway Communications, Inc., designing IBM-compatible network adapter cards for PCs. He is a member of an IEEE Standards Committee Working Group, working on Ethernet, CSMA/CD, and Token Ring Local Area Networks. Joel is "still single," with interests in yoga, meditation, and personal transformation.

Jeffrey Heller, president of Heller & Leake, Architects, of San Francisco recently returned from Soviet Armenia where he was part of the American Earthquake Urban Design Assistance Task Force. His firm's current projects span the globe from Manila in the Philippines to Orlando, Fla.

Ed Shibata is still teaching physics at Purdue University. He is making frequent trips to Cornell University for an experiment studying positron-electron annihilations. Ed and his wife stay busy renovating a house they bought at auction in 1982. He reports some progress—previously people used to ask when they were going to move in, and they already had!

Bill Harper writes from Scottsdale, Ariz., that he is currently manager of Space Power Engineering at Garrett Pneumatic, developing closed cycle gas turbine engines for space power generation.

One possible application is the growth version of Space Station Freedom. . . . Interactive Images, Inc., of Woburn, Mass., announced that **Dick Carpenter** had been elected to its board of directors. He is president and CEO of Index Technology in Cambridge, the leader in computer-aided software engineering products, which he co-founded in 1983. Previously, Dick co-founded Index Group, a consulting firm specializing in the use of information technology to support strategic business objectives. He is also serving as a trustee of the Massachusetts Software Council.

Tom Arnold remains at AT&T in Morristown, N.J., where he is Product Management vice-president for AT&T's desktop computer products and peripherals. In the lively world of computers, Tom's comment that "it's been interesting and fun" probably says a lot. He, his wife Carol, and their sons Bill and Eric continue to enjoy northern New Jersey. Bill is already thinking about college, and Eric started high school this fall.

We seem to have more geographic diversity than usual in this column. I hope that some of you "readers" will become "writers" and tell the rest of us where you are and what you've been doing.—**Joe Kasper**, secretary, RR 2, Box 4, Norwich, VT 05055

65 25th Reunion

Almost a new low in "letter count" this month. The sole entry was a note from **Dick Amster** reporting that he's living in Brookline and working in Fidelity Investments' Advanced Technology Group. Dick also advises us that he has two sons, Max, 4, and Alex, 2. . . . Let's try to get a few more cards and letters into the mill so we run up to our 25th reunion with a bang—or at least with a few full columns.—**Steve Lipner**, secretary, 6 Midland Rd., Wellesley, MA 02181

66

Jack Fuhrer is enjoying the national attention that has recently been paid to high-definition television. He directs the David Sarnoff Research Center's Advanced Compatible Television project. . . . **Mark Yogan** has been promoted to vice-president of Bayer USA. He was formerly director of strategic planning. . . . **George Randall** writes: "Ten years ago, **Dennis Overbye** told me we would all 'disappear into the technocracy.' So far, I have enjoyed the journey, as have many other classmates. I am still in Everett, Mass., importing LNG. I am happily married to my first wife and am sending my eldest daughter to Eugene Lang College in New York City.

Philip Schwartz has received the Naval Research Laboratory's 1989 Sigma Xi Pure Science Award for his "fundamental contributions to the fields of astrophysics, atmospheric spectroscopy, and remote sensing of the middle atmosphere, including the critically important problem of ozone depletion." He has been at NRL since 1971, and head of the Infrared and Millimeter Wave Astronomy Section since 1981.

That's the news. Keep it coming.—**Jeff Kenton**, secretary, 7 Hill Top Rd., Weston, MA 02193

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Sheldon Bayer manages a line of fiber optic telecommunications products for the telephone industry. He is with Rockwell International in the network transmission systems division, and writes that he is "still amazed sometimes about the number of MIT grads you wind up rubbing shoulders with here at Rockwell and elsewhere. . . . **Michael Scott** led a delegation of 30 computer industry executives and lawyers on a two-week fact-finding trip to Europe last September to study the effect of European unification in 1992 on the United States computer industry. The trip was under the auspices of the Citizen Ambassadors Program.—**Jim Swanson**, secretary, 878 Hoffman Terr., Los Altos, CA 94022

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If you were reading the *Wall Street Journal* on July 24, you might have caught a book review of *Market Wizards: Interviews with Top Traders*. In it you would have read how commodity trader Michael Marcus turned 30K into 80M in ten years. Unfortunately, he is neither one of nor related to your class secretaries. However, the review goes on to discuss **Ed Seykota**, who definitely is a classmate and is described as having "compiled the most spectacular trading record of those interviewed and maybe anywhere. One of his customer's accounts began at 5K in 1972 and was up 250,000 percent by 1988. The review quotes Ed's observations on human behavior: "Win or lose, everybody gets what they want out of the market. Some people seem to like to lose, so they win by losing." Ed splits his time between Lake Tahoe and Maui. . . . From Cambridge, we hear that **Rick Karash** has joined Symbolics, Inc. as vice-president for marketing. He was formerly an independent consultant. . . . The Naval Research Laboratory's 1989 Sigma Xi Applied Science Award was given to **Yue-Ying Lau** for "his pioneering studies in the dynamics of electron beams and for his ingenious and elegant solution of several outstanding problems in radiation and accelerator physics." The companion award in pure science was given to **Phil Schwartz**, '66.

Richard Raysman has been elected chair of the New York State Bar Association's 5,300-member Business Law Section. He received his law degree from Brooklyn Law School and is a partner in the firm of Brown, Raysman & Millstein. He lives in Manhattan and is married to Georgia Urbano, who practices trusts and estates law. They are the parents of three children. . . . From Lansdale, Pa., **William Hutchison** writes that he is porting any and all applications programs to UNIX. . . . After seven years of self-employment, **Robert Cubert** has joined the IBM Almaden Research Center in the Office Systems Group. . . . **Robert Keith McGuire** has been elected to the board of directors of the Seismological Society of America for a three-year term. He is president of Risk Engineering, Inc., of Golden, Colo., a consulting firm specializing in probability and risk applications to engineering systems. . . . After 20 years of living in various places around the country (most recently, seven years in Minneapolis), **John Dehne** and family have settled back in Andover, Mass. He is vice-president and general manager of Honeywell's ElectroOptics Division in Lexington. . . . **John Niles**, president of Global Telematics, a Seattle-based consulting firm, has been appointed senior fellow and visiting director of the Telematics and Economic Development at the Center for the New West, an independent, non-profit think tank in Denver.

Thinking ahead, **Ray Paret** writes that he is looking forward to the 25th reunion. He still has a lot to do concerning the careers of The Doors and is developing television and film projects. . . . From Miami, we hear that **Paul Gluck** is president-elect of the Florida Obstetrics and Gynecology Society and is active in the Florida Medical Association. Besides maintaining an active OB-GYN practice and serving as associate clinical professor at the University of Maryland School of Medicine, he finds time to enjoy golf with his wife and 9-year-old son. Their 6-year-old daughter can hardly wait to learn the game. . . . That's all we have for this month. Looking forward to hearing from you.—**Gail and Mike Marcus**, secretaries, 8026 Cypress Grove Ln., Cabin John, MD 20818

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Not much news to report as the academic year cranks up. A few job changers out there, accord-

ing to mysterious computer messages. **Steven D. Lipsey** is now vice-president of marketing at Reflection Technology in Waltham, Mass. He was previously vice-president of Bachman Information Systems in Boston. . . . According to the *New York Times*, **David A. Frank** is now executive vice-president of Margaretten & Co. (a subsidiary of Primerica Corp.) in Perth Amboy, N.J. He was formerly senior vice-president and treasurer of Primerica Corp., Greenwich, Conn.

Fellow former Burton 4th'er **Robert Schaeffer** is co-author of a new book, *Standing Up to the SAT* (ARCO Books, \$6.95), described by the Associated Press education writer as "a guerilla test preparation book." "The SAT is the enemy," it says. "Here are the tricks you need to defeat it." Some of the chapter titles: "How to Outwit the Verbal SAT"; "How to Outfox the Math SAT"; and "How to Outsmart the Test of Standard Written English." In 1985, Bob and fellow testing opponent John Weiss formed FairTest in Cambridge to do testing research and lobbying against the College Board, which sponsors the SAT test, and the Educational Testing Service, which administers it. Bob and his colleagues have been seeking elimination of the SAT because he believes it to be unfair to women and minority students and flawed in other ways. The book reportedly has dozens of invaluable test-taking tips, a foreword by Eleanor Smal and an afterword by Ralph Nader. Ah, for days of youth when all this mattered personally to us. Now we can only buy Bob's book for our own kids, although with a Mom or Pop from the 'tute, most of the little darlings may be too smart to need it!—**Eugene F. Mallove**, secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03304

70 20th Reunion

James F. Pelegano is now on the faculty of the medical school of the University of Wisconsin, specializing in neonatology. He is also acting with a number of local community theater groups, after having gotten his start in drama at the MIT Dramashop. . . . **Neil J. Colvin** is now the chairman and chief technical officer for Phoenix Technologies in Norwood, Mass. . . . **Peter B. Kramer**, having pursued various careers in physics and medical instrumentation, is now assistant director of licensing of biotech pharmaceuticals for Johnson & Johnson. He lives with his spouse and two children in Princeton, N.J. . . . **Eric K. Clemons** and his spouse recently announced the arrival of their first child, Julia. They reside in Bryn Mawr, Pa.

Julia Norton writes that she and the family toured the United States and visited friends for two months this past summer. She loves teaching statistics to graduate and undergraduate students, as well as coaching little league and softball, involving their three children. . . . **Terry D. Bennett** and spouse now have three young children and have recently moved to Portland, Oreg., and love the northwest part of the United States. He joined FPS Computing (formerly Floating Point Systems) as director of marketing. . . . **Sandra Lazarowitz** has been in the Department of Embryology at the Carnegie Institution of Washington since 1982. She is a staff associate, using a molecular genetic approach to investigate two geminiviruses that are responsible for worldwide economic losses. She received a Ph.D. from Rockefeller University, studying animal virology, and was a postdoctoral fellow at Johns Hopkins Medical School.

Edward J. Chalfie has joined the national law firm of Keck, Mahin & Cate, in their Chicago office. Formerly, he practiced law with Epton, Mullin & Druth, Ltd., specializing in intellectual property law, including patent, trademark and copyright matters. . . . **Ernest L. Hall** has received the GE Research and Development Center's highest honor—its Coolidge Fellowship Award—for leadership in the field of electron microscopy and its application to problems in

materials. His work has included grain boundary structure and chemistry in metals and ceramics, and he has pioneered several investigations that have contributed to the solution of complex physical metallurgical problems and have been critical to the development of new engineering materials. He has acted as an adjunct professor at RPI and has authored or co-authored more than 120 technical papers. He received his Ph.D. from MIT.

Alfred Langguth has finished building a victorian home in southern New Hampshire and is continuing to develop low-cost ultrasound medical systems for Hewlett Packard as an R&D project manager. . . . **Richard Nagy** is still working with GTE in the department involving government systems reorganizations caused by defense budget changes.—**Robert Vegeler**, secretary, Beers, Mallers, Bachs, Salin & Larmore, 1100 Ft. Wayne Natl. Bank Bldg., Ft. Wayne, IN 46802

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Neil J. Colvin was featured in the *Boston Business Journal*. Neil's company, Phoenix Technologies, has net sales of over \$44 million and net earnings of close to \$8 million. In addition to receiving an SB in electrical engineering, he also received an MS in engineering and applied physics and computer science from Harvard in 1973. . . . **Donald G. Roth** writes: "Currently building front office trading systems in capital markets and foreign exchange at Chase Manhattan. Anybody else from the Class of '71 working on the street, stop by." . . . **Art Gershkoff** writes: "I am currently settled in a Philadelphia suburb and happily married with two children, Daniel (5) and Danielle (1). I have been working at Magee Rehabilitation Hospital in Philadelphia where I have been the attending physician for seven years, working primarily with elderly persons with strokes and often disabling illnesses and teaching medical students and resident physicians.

Congratulations to **Sally (Harvey) Johnston** and **Malcolm Johnston** on the birth of Douglas Newton Johnston born last August, 9 lbs. 2 oz. Sally is on leave from Digital Equipment enjoying the "mommy track." She and her husband, who works at Draper Labs, were married in September 1988. They moved to Belmont in June 1989 to get ready for the baby.

Please keep your cards and letters coming; your friends want to know what you have been doing.—**R. Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

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Scant news this month. A note from **Robert Sorrentino** reports: "Recently elected chairman of the Department of Emergency Medicine at St. Mary's Hospital in Tuscon. I am president of Partners in Emergency Practice, PC, which operates the Emergency Department at that hospital. I am also still active as a consultant for computer applications in the health care industry. Margo and I and our children are spending the summer at Camp Pearlstein in Prescott, Ariz., with me as camp doctor."—**Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

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Lots of class news to brighten up a dull, dull, rainy day here. In the quickie department, **Joel Franck** was certified as a diplomate of the American Board of Neurological Surgery; his private practice is in Lewiston, Maine. . . . **Wes Grandmont** is currently vice-president of GLS Constructors, a New England industrial contractor and developer of co-generation facilities and small bio-energy plants. Wes also admits to his Theta Chi buds that his 228 bowling average for 1988 is based on one game.

Danny Klein bowls, I know, because we were

on the same team in Chicago in 1968. He's now senior vice-president of ICF Resources, an energy and natural resources consulting firm. Dan wonders if other '73ers have been with the same company. . . . **Aaron Roberts** became a civil servant, working at NASA's Goddard Space Flight Center studying interplanetary turbulence and making pretty pictures with Mac IIs. His wife, Laurie, is a physician, and they have a daughter, Shoshana ('09). . . . **David Moylan** recently con-

"Moving from the corporate world to a start-up is a lot like making the transition from high school to MIT. The people are exciting, the technology fascinating, the pace blinding, the work load stupefying, and the outcome uncertain."

BILL FREZZA, '76

tributed a chapter on clinical hyperthermia to a new textbook on therapeutic radiology published last September. He is now working on his private pilot's license.

David Reed, of spreadsheet fame, was appointed chief scientist for all spreadsheet-based products at Lotus Development, to be responsible for implementing advances in spreadsheet technology.

A letter arrived from **Ken Rosato**; he is at Amoco in Houston as a staff title survey engineer. Ken spends a lot of time shuttling back and forth to Alabama, where Amoco is doing a coalbed methane degasification project. In July his family had a nice visit with **Bill Blum** in Brooklyn. At a visit to the Tute, he ran into **Phil Fuhrman** in front of Paul Revere's tomb.

That's it, folks!—**Robert M.O. Sutton, Sr.**, secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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Please send news to your class secretary.—**Lionel J. Goulet III**, secretary, 115 Albemarle Rd., Waltham, MA 02154-8133

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15th Reunion

Just one item this time. I received a nice note from **Arlo F. Weltge**. He and his wife, Janet, had their first child, Frederick (6 months and growing). Janet has recently started a fellowship in oncology at M.D. Anderson Hospital. Arlo recently left a group of emergency physicians he had helped form over eight years ago. He had been a director and served as president until he was offered a job as faculty (assistant professor of surgery) at the University of Texas. Arlo will be the

director of the new Lyndon Baines Johnson County Hospital Emergency Center when it opens in July 1990. Until then, he will be attending at Herman Hospital and working with "Lifelight" there. (Did I read your handwriting correctly?) Finally, Arlo had been visited recently by Joanne and **Guy Plunkett** and their 7-year-old son, Ben. They have moved back to Madison, Wisc., where Guy will be working at the University of Wisconsin.

That's it for now. Keep writing.—**Jennifer Gordon**, secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036

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We have a goodly amount of news from the mails. However, you should all still strive to write or call.

Cheryl Marceau has been promoted to the director of Human Resources for the Bedford, Mass., operations of MITRE Corp. MITRE is headquartered in Bedford. Cheryl joined MITRE in 1986 as their manager of employee relations and benefits. Before joining MITRE, she was at GTE, also in human resources. . . . **David Anick** has been awarded a Sloan Research Fellowship for two years from the Alfred P. Sloan Foundation to support fundamental research.

From **David August**: "Finally, after almost 13 years at Yale, a move! I've accepted a faculty position as a surgical oncologist at the University of Michigan. I start in September (1989), and I'm looking forward to having more time to meld my clinical and laboratory interests." . . . **Dorothy Harris**, M.D. writes, "Married Thomas Forbes in September 1988, was appointed an assistant professor at Rush Medical College in January 1989, and am expecting a baby in July (1989)." . . . And from **Peter Kaufman**: "Marie and I are the proud parents of a healthy, delightful son, Benjamin John Kaufman, born March 14, 1989."

Frank Ruiz writes, "Attended Mike Corwin's wedding on Sunday, June 25—quite a nice affair held in Ridgefield, Conn. He finally bit the dust! Yours truly is very busy as Chairman, ASTM D10.33 Subcommittee on Refuse Bags. It is quite a challenge trying to get a half-dozen competitors to agree on anything. Being employed by a manufacturer of refuse bags also keeps me in the eye of the solid waste/degradable plastics hurricane, watching technology, policy, and b.s. swirl by." . . . **Rev. A. Carl Sharon** says, "Finishing my time as associate pastor at Trinity Lutheran (New Haven) and will be concentrating my efforts on campus ministry at Yale. Am starting a 'Faith and Science' group among faculty and students—very exciting. My wife, Christi, finished her MDV this May and is looking for a teaching job. Bumped into **Tom Openshaw**, who is expecting his third child this summer. Tom is an MD at the Yale Health Plan."

After almost 13 years, I have finally heard from **Bill Frezza**: "After several years at Bell Labs and then General Instruments, I moved from engineering to marketing, first at a technology consulting firm in Princeton, N.J., and now as a member of the start-up team at Agilis. Agilis is a VC (venture capital) backed computer manufacturer about to launch the 'mobile computing' business. In June we will announce a line of rugged, modular handheld workstations and wireless local area networks for out-of-office environments. Though headquartered in Silicon Valley, we opened a regional office in suburban Philadelphia comprised of a group of us that had spun out of the aforementioned consulting firm, where we had done some early pioneering work in high-speed spectrum wireless LANs.

"Moving from the corporate world to a start-up is a lot like making the transition from high school to MIT. The people are exciting, the technology fascinating, the pace blinding, the work load stupefying, and the outcome uncertain. While it's hard to predict where it will all lead, I think we are well positioned to catch a wave that

will bring the personal computer revolution to a large portion of the workforce that has thus far been left out—field engineers, maintenance workers, cops, firemen, aircraft mechanics, truckers, and even traders on stock exchange floors. . . . Regards to my fellow classmates and frat bro's. I have not missed a single annual Chi Phi initiation/alumni banquet since my own in 1973." . . . He also sent word about **Bob Bulger**, who is living in Wayne, Maine, and is working for the State Highway Department building roads and bridges.

Tom Moran is living in Palo Alto, Calif., and is running Stanford University Hospital's clinical lab information system and writing erotic poetry in his spare time. . . . **Stan Knutson** says, "Started with ICAD, Inc., in Cambridge, a software company dedicated to revolutionizing mechanical engineering, in June 1989. The product is a program that greatly speeds the design of complex assemblies such as power plants, A/C systems, aircraft, etc. I will be project manager for user interfaces, with responsibility for all the graphics parts of the program. So far it has been interesting. I have been studying LISP as well as some of the far more abstract computer science used in making the ICAD system work. I have not done this much studying since leaving MIT! . . . **Fred Knoll**, president of Knoll Capital Management, has been appointed chairman of C3, Inc., of Herndon, Va.

As for your secretary, times have been mixed. I came down with pneumonia, which slowed me down considerably for a while. The currency markets and stock market, at the same time, continued to have major moves. So did coffee and cocoa, straight down to 14-year lows! I do not lack for both volatility and trends. On the high tech side, by the time you read this, we will have voice operated PCs on the U.S. Government's General Services Administration (GSA) schedule using the voicebox. We will, (also hopefully by the time this is read), be in production of our next voice product, which I have tentatively named the "Scribe." It is the dictating typewriter. Its vocabulary is the *Random House Dictionary of the English Language*. On an 80386 machine at 25 MHz, it takes dictation at up to 80 wpm. We are planning to bring this up to approximately 125 wpm via the introduction of our own 80386 clone, which will have a speed of 58 MHz. We will be retailing the PC alone at \$7,500, and with the Scribe at \$16,000. Between the futures and the above high tech activity, plus family, my days and nights remain quite full. Nevertheless, you should all write, call, or fax me news of yourselves. I am always in need.—**Arthur J. Carp**, secretary, Stalco Futures, Inc., 254 West 35th St., 16th Floor, New York, NY 10001, (212) 736-1960, Fax: (212) 736-3664

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Please send news to your class secretary.—**Ninamarie Maragioglio**, secretary, 8459 Yellow Leaf Ct., Springfield, VA 22153

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Sheila Luster writes us from Eules, Tex.: "We've relocated to the Dallas/Fort Worth area, where my husband, Kevin N. Wade, '79, is flying for Delta Airlines. I'm going into the house renovation business (investors are welcome!). We find that the area offers quite a bit in sports and travel, and family is relatively near for a change (only seven hours away!). Erika is now 19 months old and is quite enjoyable when we aren't battling over 'exactly who does run this place anyway?'"

Much farther north, **Mike Nathan** writes: "I am a chief resident in internal medicine this year at the Rochester (N.Y.) General Hospital. Michele Walczak and I got married in October 1988. I am still interested in medical anthropology and may pursue a (part-time) graduate degree if we can

find a program in a place that suits us both."

Mike and Michele are living in Rochester.

Mike Geselowitz writes, "I am returning to MIT as a lecturer at the Center for Materials Research in Archaeology and Ethnology, which is housed (for as long as it continues to stand) in old Building 20." Mike invites classmates to stop by and say hello. Mike lives in Cambridge.

Up the river from Mike and the Tute is **Gerry Epstein**: "After ten years, I have moved back to Cambridge to take a position in the Science, Technology and Public Policy program at Harvard's Kennedy School of Government. I am directing a project there on dual-use technologies. It's a little different working up the street, but I have managed to play on an MIT softball team this summer." Gerry is living in Watertown, Mass.

From a news clipping, we learn that **Ray Dugal** is now a radiation oncologist at St. Anne's Hospital in his native Fall River, Mass. He is also a lecturer on radiation therapy at Harvard Medical School.

Milton Royce was in town for MIT business including a meeting of your class officers (Milt, **Phil Kesten**, **Diane Curtis** and your class secretary), to discuss class communications and projects. Milton and wife Gloria Lara are expecting their first child in December. Milton and Gloria met at Harvard Business School and then went to work for competitors in the Motor City (Milton for GM and Gloria for Chrysler). Should be interesting as they pursue their individual fast tracks in "The Only Game in Town" in Detroit!

Milton tells us that he and Gloria were joined by classmates **Libby Seifel** and **Steve Melnikoff** (who hail from Palo Alto, Calif.) at the September wedding of Amy Powell, '79, in Washington, D.C. Having just recently returned from a month-long trip to Egypt and Israel, Libby will again take a leave of absence to make an extended journey to Australia and other points west.

At this writing, a Class of 1978 class project is under way at MIT, under the able chairmanship of **Phil Kesten**. Our class is assembling "CARE" packages that parents may purchase for their undergraduate children, to be distributed by our classmates before the fall term finals week (when, as you may remember, such goodies are most needed and appreciated!). It's a great opportunity for contact between alumni and undergrads, and a promising fundraiser for class projects, among which is the Class of 1978 Student Aid Fund. A future column will tell of the results of this exciting project.

Your class secretary and wife **Diane Curtis** will be located somewhere in northeast-central Ohio by the time you read this. We plan to rent a home while we search for a farm to buy. As this is being written, however, we are working hard to finish up software development projects and prepare for our move to the Heartland.—**Jim Bidigare**, secretary, c/o *Technology Review*, MIT, Bldg. W59, 201 Vassar St., Cambridge, MA 02139; **Julie Kozaczka Stahlhut**, assistant secretary, jstahlhu@hstbme.mit.edu; Compuserve: Julie K. Stahlhut 76566, 1012

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After the last two columns, this one is going to seem a little skimpy. Voice your dissatisfaction with skimpy columns by writing to me TODAY! . . . **Pete Steinhagen** wrote a nice long letter with lots of news. He says, "We are enjoying our new spot in Alexandria, Minn., having moved up here in November of 1988 from the Twin Cities. I am still with 3M after 10 years, doing process engineering, making sandpaper. Janet and I are both ready to settle in after three corporate moves. We have a home on Lobster Lake, and our kids love it. Chet was 5 in April, and Maria will be 3 next week. My big summer projects have been building the kids' swingset and keeping the old '59 Johnson Seahorse running."

Pete also reported the following on his fellow

SAE and baseball alumni. **Joe Kracunas** and **Debbie Brooks** were married in June 1988, and one year later their daughter Allison was born. Joe works for General Electric, and they live in Groveland, Mass. . . . **Kevin Holland**, who lives in North Palm, was at Joe's wedding. . . . **John Hayashi** was, at press time, planning a move to Los Angeles to work for Touche Ross. John had been at the Mark Twain banks in St. Louis for the last several years. . . . **Al O'Connor** has started a company called America By Mail, Inc., which produces coupon books for specialty mail-order companies. Pete pronounces the book to be very well done. Al lives in the Boston area. . . . **Steve Garverick** and his wife, Linda, live in Galway, N.Y. with their 1-year-old daughter, Susan Elizabeth.

Deborah and **Steven Feldman** had a 7-pound, 8-ounce baby boy named Andrew Seth on July 10, 1989. . . . **Richard Gray** left Amoco after seven years, having worked both in "downstream" (refining and marketing) and "upstream" (drilling) operations. He is now with Union Pacific Railroad in Omaha, Neb., pursuing operations research applications. . . . **Brian Peskin** is the CEO of Ultra Wash, the only company specializing in on-site mobile commercial fleet washing. The company has offices in 30 cities. . . . **Earl Lipson** says, "Just celebrated my second anniversary with my best friend and wife, Sasha Korper. We have a beautiful 7-month-old, Taiga, who specializes in fluid dynamics and telecommunications (i.e., diapers and crying!). Please send regards from me to the 'Burnside Boys' . . . That's all for now.—**Sharon Lowenheim**, secretary, 500 E. 63 St., Apt. 18B, New York, NY 10021

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10th Reunion

Please send news to your class secretary.—**Kate Mulroney**, secretary, 118 Riverview Ave., Washington Crossing, PA 18977

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Happy New Year! Hello everybody from warm and sunny Boca Raton, Fla. Ned, Eric, and I moved here from Boston last summer and are finally getting settled into our new house, new jobs, new lifestyles, etc. We sure don't miss all the cold, snow, and ice, but we already miss friends and pretty New England. Now that we have "narrowly" missed the path of hurricane Hugo, we look forward to a beautiful winter. Please make note of my new address and write.

Let's start off with new babies! Congratulations are in order for **Keith Byerly** and his wife Anne Kelly on the birth of their third child, Elizabeth Anne, who was born last June 20. She joins 3-year-old twin brothers Michael and Daniel. Keith is a technical marketing manager for Hewlett Packard in Waltham, Mass., and lives in Wellesley Hills. . . . Another baby born in the Boston area is Christopher Matthew Cheng (1 year plus), son of **Daniel Cheng** and his wife Cindy (Wellesley, '79). They are currently living in Maynard, Mass. . . . **Michelle Lucier-Glatz** and her husband Bob are the proud parents of daughter Shannon Marie born July 26, 1988. Michelle transferred to Raleigh, N.C., with IBM and is working in the Telecommunications Department, while husband Bob attends Law School at UNC, Chapel Hill.

In the PhD category, **Cathy Hunter** received a doctorate and postdoc training in bioengineering at the University of Pennsylvania and is currently working in the Oral Care Research Department at Colgate Palmolive in Piscataway, N.J. . . . **Debye Meadows Galaska** is a bioenvironmental engineer in the U.S. Air Force and has been living in Guam. This summer she began a master's program in industrial hygiene engineering at Johns Hopkins University. She writes that she and her husband, Pat, have six wonderful children between them and that life is without a dull mo-

ment! Debye would like to know how **Janet Grzyvacz** is doing and reports that **Ron Tyler** graduated from Berkeley Law School.

Wedding bells were ringing for **Armando Viteri**, who married Suzanne Rollier last August 19 in Cold Springs, N.Y. Suzanne is a marketing manager at DEC. They honeymooned in Hawaii and Ecuador and have moved to California, where Armando is the group marketing manager for SPARC Technology at Sun Microsystems. Armando has been with Sun Microsystems for almost six years. . . . Also in the marriage department, **Cliff Meyer** was married on July 4, 1988, to Eunryeong Ju of Seoul, South Korea, Boston College (Ph.D. '92), after four years of "going steady." Cliff traveled to Korea for one month to meet his wife's family and says that "it took a while for this stiff engineer to sit and eat dinner Eastern-style with his new in-laws." While in Korea, Cliff met up with old TDC roommate Kevin Wojahn, '80, who is stationed at Osan AFB and is flying F-16s.

I received a press release from the California Institute of Technology. It seems that two of our classmates are among the seven Caltech faculty named Presidential Young Investigators. Included in this group are **Harry Atwater**, assistant professor of applied physics, and **Andrew Myers**, assistant professor of chemistry. Congratulations.

Thanks to Ann Zablodoff, '86, and Cindy Paschal, '85, we have news of **Jon Peltier** and **Cindy Zannetof Peltier**. They and son Francois are living in Gillette, N.J., where Jon works for Allied Signal Corp. The big news is that Jon and Cindy have opened an American-Greek diner that they have named "Cindy's Olympus." Cindy runs the diner, and rumors indicate that Cindy's great cooking is making the place a real success! Please fill us in on the details!

Sharon Lowenheim, '79, forwarded a letter she received from classmate Pete Steinhagen that included some '81 SAE news. **Carl Nowiszewski** and his wife Kay and son Michael have moved to Connecticut from a "Newhart-esque" setting in Vermont. . . . **Jeff Olson** is still living in Boston. . . . **Bobby Clarke** recently married Beth McInerney. . . . **Andy Ubel** continues to work at 3M in St. Paul. He and his wife Meg also have a lake cabin in Wisconsin for get-a-ways. Thanks, Sharon and Pete, for passing the basic news along. Maybe Carl, Jeff, Bobby, and Andy will fill us in on some more details.

Michel Bayloq claims that he should be awarded the procrastination award for meaning to but not having written for years. (Please don't be so presumptuous, there are many contenders for this dubious distinction!) . . . After seven years at Lockheed in Sunnyvale, **Michel Wright** and his wife Mary, '82, have moved to Toulouse, France. Michel is working for a French Aerospace firm, Matra Espace. . . . **Chung K. Ko** writes that he has been named assistant professor in the Department of Electrical and Computer Engineering at Rutgers University in New Jersey last fall. . . . **Edward Valdez** received his MBA from the Executive MBA Program at the University of Texas in Austin. He is working for the Asia Pacific product marketing group of advanced micro devices in Austin, Tex. . . . Also living in Texas is **Claudia Perry**, who lives in Houston and works as an entertainment writer. She writes that the "thursday family" is alive and well!

Back in the Big Apple, **Armand Tatevossian** became a vice-president in the derivative products global marketing group at Bankers Trust this Spring. . . . Also in Manhattan is **Marjorie Madson**, who is having much fun in her new job at the start-up company, Pearl Meger and Partners. . . . Back in beautiful Cambridge, Lt. **Thomas Eccles**, USN, has spent the last two years in the MIT Ocean Engineering Department pursuing the degrees of naval engineer and SM in mechanical engineering. This past June, he began the 12-month Master of Management Technology Program at the Sloan School. Then in June 1990, Tom will resume his Navy career in ship design.

I received a nice letter from **Charles "Chuck"**

Markham. Chuck has left Bain & Co. He has remained in Boston and is currently working for John Hancock Venture Capital. He claims to be having lots of fun, working reasonable hours, and doing interesting work. Not bad for a job! . . . That's about it for now. Please keep the cards and letters coming.—**Lynn Radlauer Lubell**, secretary, 2380 NW 41st St., Boca Raton, FL 33431

82

Congratulations to **Rick Cohen** and **Mindy Garber** on the purchase of their first home, in Arlington, Mass. . . . The housewarming party last fall was full of '82ers, including **Peter Mui**, **Richard Schaaf**, **John Woods**, along with his wife Enid and their 1-year-old daughter Sara, and **Bill Cattey**, who is working at Project Athena and owns a home in Watertown, Mass., with Evan Williams, '84. . . . **Patty Cullen**, another guest, was on her way to Fort Collins, Colo., where both she and her husband should by now be working for Hewlett-Packard. . . . Patty reports that **Eric Leiser** has returned from Taiwan and is working in the Silicon Valley.

Chris Braun returned last summer from a 15-month tour "stranded out on the frozen wastelands of the South Korean mountain sides in charge of a highly motivated communications platoon." He is now stationed in Fort Monmouth, N.J., and "doing some real science stuff" in an Army laboratory for high-power electronics research. . . . During his travels, Chris caught up with **Matt Weinberg** who gave up his studies in the economics and technology program at Stanford to work at a small start-up semiconductor company making fast RAMs.

Paul Czarnecki and his wife Sydnia celebrated their sixth wedding anniversary last summer. They are living in southern New Hampshire. Paul writes that he has "become quite a motorhead since leaving the Institute," serving as a Flagging and Communications official with the Sports Car Club of America, competing in his CRX in the local autocross circuit, and restoring a 1954 Ford.

Thomas Lawton wrote to catch us up on what he's been doing since graduation. From 1982 to 1984 he worked as a field engineer for Flopetrol/Schlumberger in Europe and on the west coast of Africa. He and **Bill Chesterson** then started their own engineering/machine design firm, where they're "working harder than at school." . . . Last year **Paul Gault** received an MBA from Harvard and was promoted to area manager for ingot making at the Timken Company's Faircrest Steel Plant. Paul has worked for the company since graduating from MIT.

Keep that mailbag full! Write soon to East Coast correspondent **Linda Schaffir** (50 Aiken St., #512, Norwalk, CT 06851), West Coast correspondent **Michelle Gabriel** (656 S. Fair Oaks Ave., D-211, Sunnyvale, CA 44086), or me.—**Stephanie Polack**, 135 Sutherland Rd., Brighton, MA 02146

83

I received a letter this month from **Michael Wellman**, who is now living in Dayton, Ohio. Michael finished his dissertation at MIT in August 1988 and is now serving his ROTC commitment, which he was able to postpone for graduate school. Michael is also continuing his work in artificial intelligence while in the Air Force. Now to top it all off, Michael was married in August 1989 to Kate Unrath. Attending the wedding were **Shawn O'Donnell**, **Beth Markey '84**, **Ruy Cardoso**, **Peter Lee**, **Roy Hirshkowitz**, **David Cooke**, **Sara Keagle Cooke '85**, and **Catherine Coleman**. Michael reports that Ruy passed his tenth and last actuarial exam and is now a fellow, while Dave is a resident in pediatrics at Johns Hopkins. Roy was married last year to Pam Carter and now lives in Seattle, where he works as an architect and climbs local mountains when he gets the chance. Congratulations, Michael, and

thanks for the news.

The following people took the time to jot down what they were doing while giving to MIT. **Matt Haggerty's** wife, Carol, wrote to announce the birth of their son, Andrew Mark. Matt and Carol just bought their first house in Milton, Mass., and Matt's company, Product Genesis, Inc., is doing well and is located on Bent Street in Cambridge. . . . **Kei-Mu Yi** writes that he is finishing up his Ph.D. in economics at the University of Chicago and has been appointed assistant professor at Rice University for the fall of 1989. . . . **Duncan Blanchard** writes that he is programming entertainment software for Mediagenic in Menlo Park, Calif.

I got a call from **Steve Janowsky**, trying to solicit money from me for MIT. The guy was ruthless—I told him I already gave this year and he wrote me down for a pledge anyway. Steve will be graduating soon from the Harvard Graduate School of Physics. He reports that **Betsy Polack** just bought a condo in Cambridge and is currently working for ITT, while **Dean Potashner** is now a first-year student at Wharton.

I received a press release from MIT mentioning that **Calvin Stubbins** has been appointed to the physics faculty at Franklin and Marshall College in Pennsylvania. Calvin is currently completing his Ph.D. at Stanford.

As for me, it's back at school for Round 2 at HBS. I had the pleasure of entertaining **Kinta Foss** and **Mike Santullo**, who stopped by last week while doing some work on the East Coast. Mike was on his way to Italy, where he was going on a bicycling vacation. Keep the cards and letters coming!—**Jonathan Goldstein**, secretary, 2 Soldiers Field Park, #201, Boston, MA 02163

84

Tue Nguyen holder of seven MIT degrees with a quintuple undergraduate major, was honored at the White House over the summer. The ceremony was part of Captive Nations Week honoring the achievements of new Americans who have overcome formidable barriers. Tue is originally from Vietnam. He is now working on semiconductor process technology for IBM in Essex Junction, Vt. . . . **Robert Leong** is a volunteer teaching the art of Chinese lion dancing. The classes have brought together a group of people who may have otherwise felt a bit lost, many in a new country, and helped them to maintain a sense of identity and culture. Robert works for Mentor Graphics in Beaverton, Ore. (clearly a fine place for an MIT alum to live).

Mark Radlauer finished medical school and is interning at Carney Hospital in Boston. Next year he will be in residence in a Denver hospital. He also managed to find time to travel to Nepal, India, Kenya and Tanzania. . . . **Greg Brandeau** should just about be finished with his Air Force tour of duty. He says he will be joining an electronic-interconnect startup company when he gets out. . . . **Edward Kneller** is serving at the Naval Aviation School in Pensacola, Fla., and was recently promoted to ensign.

Neil Savasta was the first to contact me by electronic mail. He is still working for Oracle in California. Neil says his work is "enjoyable and demanding." When an ex-Bakerite social chairman says demanding, it must be serious. I figured I would be flooded with electronic mail, but Neil was the only sender. Come on, I know you are out there: hbr@ai.mit.edu.

Back at MIT, the renovated student center will be getting a Toscanini's ice cream store. Ah, civilization at its finest! From Boston, **Howard Reubenstein**, secretary, 38 Belknap St., Somerville, MA 02144, (617) 625-9299

85

5th Reunion

Adam Brody is working at NASA-Ames Research Center in Mountain View, Calif. He is in charge

of proximity operations (activities occurring within a 1-km. sphere of the space station such as rendezvous, docking, and repair) research and has been experimenting with a flight simulator that he developed. He also created an orbital trajectory planning tool that runs on the Macintosh and published a paper about it and several others on related topics.

He presented two papers at the Aerospace Medical Association's annual meeting in 1988, one at the Digital Avionics Systems Conference in San Jose, one at the Aerospace Sciences Meeting in Reno, one at the Space Operations Automation and Robotics Workshop in Houston, and one at the InterSociety Conference on Environmental Systems in San Diego. He also published three NASA contractor reports and two articles in the *Journal of Spacecraft and Rockets*. He spent one week at the Johnson Space Center participating in some astronaut training. Adam was nominated to *Who's Who in the West* and won the Division III men's singles title in the Mountain View City Championship Tennis Tournament in 1988. In 1989 he was named the Most Valuable Male Player and serves as the membership chairman. Last summer Adam vacationed in Israel and France. While he was in Haifa, Israel, he visited Technion (Israel's MIT). He was very impressed and says it is similar in population as well as focus of study to MIT.

Tom Hershey received a master's degree from the UCLA Divinity School. . . . **Rich Berger** received his MD from Tufts University. His internship is at University of California at San Francisco, and his specialty is proctology. . . . **Ralph Hyre** is working at Pharos Technologies in Cincinnati, Ohio.

Stewart Cobb is working at the Space Systems Division of the Air Force in Los Angeles. He is planning space flight opportunities for DOD experiments. Before that, he worked at NASA on the STS-26, 27, and 29 Shuttle flights from the GNC (Guidance, Navigation, and Control Systems) console in Mission Control. He was in Boston over Labor Day weekend and visited the Tute in the midst of R/O week. He also learned to fly while he was in Houston. Since the LA skies are so smoggy and crowded, it is not as fun to fly there.

Ken Katz is flight-testing B-52 electronics at Edwards AFB. He had a party which attracted a bunch of alumni.

Cynthia Paschal decided to pursue a PhD after working as an applications scientist in magnetic resonance for Siemens Medical Systems, Inc., in the Dallas/Fort Worth area. She finished her second semester in biomedical engineering at Case Western Reserve University in Cleveland, Ohio, last spring. During her two years with Siemens, she traveled extensively and found that when it comes to MIT alumni it really is a small world. She saw **Kip Kuntz** in Hawaii, **Torkil Mugstad**, G '86, at the Orange County, Calif., airport, **Pat Peters** at the 4th of July fireworks in Fort Worth, and several of her fellow Course 22 grad students at conferences in New York and Boston. She enjoyed working on the program committee of the Dallas/Fort Worth Alumni Club and is squeezing in the time to attend some alumni activities in northern Ohio.

Hisaya Sugiyama received a master's in architecture from the Graduate School of Design at Harvard last March. He moved to New York City in July to start working for Kohn Pedersen Fox, a firm in midtown Manhattan. Tom Jin, '84, and partner Bill Pedersen, MAR '64, work there too.

Clara Chung Fleisig married Glenn Fleisig, '84, last Memorial Day weekend in her home town of Manhattan, Kans. Among those at the wedding were: John Repko, '82, Eric Fleming, '83, Kyu-Woong Lee, '83, Aaron Jungreis, '83, Paul Shim, '84, Mark Novick, '84, Mike Agronin, '84, Howard Gordon, '84, Mary Holly, '84, Dave Abramsky, '84, Grant Johnson, '84, Art Gibson, '84, **Adam Helfant**, Arun Ram, '87, and Louis Pepe, '88. In May, Clara also graduated from the University of Kansas Medical School. She is now

working towards a Master of Public Health degree at the University of Alabama in Birmingham. Glenn is the coordinator of biomechanics at American Sports Medicine Institute, also in Birmingham.

Megan Donahue is a doctoral candidate in astrophysics at the University of Colorado in Boulder. She expects to receive a degree this May. Her husband, Mark Voit (Princeton, '83), and she are currently involved in "transforming the planet."

. . . Last April **Adam Cohen** became project manager at 3D Systems, Inc. The company manufactures a machine that generates instant prototypes of CAD designs by solidifying liquid plastic with a laser. Lt. (jg) **Justin Ryan** received his Navy jet pilot wings a year ago. He and his wife, Peggy, moved to Virginia Beach, where he flies the A-6 Intruder.

Please send me mail!—**Stephanie Winner**, secretary, 1026 Live Oak Dr., Santa Clara, CA 95051, internet:winner@apple.com

86

Not a lot of news this month. Please work on those letters. **Scott Bentivegna** is a U.S. Navy officer aboard the U.S.S. *Ulysses S. Grant*. He is also an assistant Scout master for Troop 43 in Waterford, Conn. . . . **Tom Eccles** is a captain in the U.S. Army working as an environmental engineer with the Army environmental hygiene agency. . . . **Yasmath Ahmed** was among 47 medical students across the country to receive research training fellowships sponsored by the Howard Hughes Medical Institute. Yasmath is a third-year med student at Duke.

Roland Overlette will be attending University of Illinois this fall, pursuing a master's in electrical engineering (computer architecture) as a participant in the GEEP program at DEC. Moving away from the Boston area has caused Roland's bridge games to be put on hold. He, **Chris Kim**, **Paul Hsu**, and **Riaz Amdaee** have been getting together regularly for two years now. Chris and Paul are at Tufts Medical School, and Riaz works for Boston Children's Hospital. . . . **Susan Downing** has founded her own theatrical company, Inanna Theatre, which staged its inaugural production of *The Two Gentlemen from Verona* in August at the Leland Theatre, Boston Center for the Performing Arts. Susan directed the production. . . . **Ed Curran** has completed his first year with Solvay (chemicals and plastics) where he has been training in Europe for a year or two. Living in Brussels, Ed gets to travel around Europe for both business and pleasure. He enjoys the beer, the chocolate, and the Belgian waffles, but he does miss New York State corn-on-the-cob. Once finished with training, Ed will have to return to one of the plastics plants here in the U.S.

Michael Howard got married to Jill Rutherford (Simmons, '87) last August. They moved to Chicago where Michael started business school at University of Chicago. Jill is employed as a physical therapist for Rehabilitation Institutes of Chicago. **Bob Duronio** was an usher at their wedding, and many other Kappa Sigs attended. . . . **Brian Miller** is starting business school at Stanford this fall. . . . **Chris DaCunha** is also there, starting his second year.

I ran into **Ray Covert** at a volleyball tournament in Hermosa Beach (my team got 4th out of 16). Ray works for Northrop Aircraft Division in Hawthorne, Calif. He spends a lot of time body surfing in Hermosa. **Greg Harrison**, **Sonya Sakai**, **Vogtmann** and **Rob Dare**, '84, participated in the tournament. **Grace Tan** also showed up. John Davis, '87 was one of the tournament's coordinators. Greg will graduate from USC in December with a master's in aerospace engineering. . . . **Ron Bloom** gave me a call while he was in Los Angeles. Ron was down on business for Boeing and got to spend the weekend in Hermosa Beach.

Please write.—**Mary E. Cox**, secretary, 1800 Hermosa Ave., No. A, Hermosa Beach, CA 90254

87

George Borhegyi has been working at Cambridge Technology Group on Vassar Street (remember those buildings with the yellow awnings?) with lots of other MIT grads. He's living in Medford with Lee Schlenger, '88, and Sharon Weber, '88—all alumni of New House Two. Also working at Cambridge Technology Group are **Lowell Kim** and **Matt Kaplan**. Congratulations go to Matt, who was recently engaged to Kathy Bleakney.

John Clarke wrote in from the Big Apple. He's still working in sales for IBM in downtown Manhattan. John just moved to a new apartment in Greenwich Village and bought a vacation house in the Adirondack Mountains. He's spending his time training for some upcoming triathlons (biking and running), and his most recent adventure was a trip camping in British Columbia.

John Penny wrote in from Burbank, Calif. John is working at Hughes Aircraft L.A. in the Satellite Attitude Control System Department. He's also a part-time student at the University of Southern California getting an MS in ME/controls. John lives with Rick Russell, '86 and Pale Archer, '86.

News from the Bay area: **Andy Chang** is at Fairchild/Milpitas designing circuits for image processing, and **Randall Honke** is finishing up a master's degree in control systems at UC/Berkeley.

Navy Ensign **Stephen J. Thome** has been designated a naval aviator. Presentation of the "Wings of Gold" marked culmination of 18 months of flight training. Stephen's curriculum included basic studies in engineering and navigation, training flights in simulators, aircraft familiarizations, basic and advanced instrument training, extended navigation flights, and landings aboard an aircraft carrier.

Jim Lin writes in with some information on some classmates he saw while vacationing between his summer and fall quarters at University of Chicago Medical School. . . . **Dave Maes** just got a master's from MIT (Course 6) and started work in Silicon Valley at Maxim Technologies. . . . **Jay Cohen**, **Rob Swiston**, and **Rosanne Park**, '89, are all working at Oracle. . . . **Ken Munson** is working at Amdahl, and **Danny "Dano"** Orange, '85, is in Santa Cruz studying his rocks and surfing. . . . **Krishna Komanduri** is in the third year of medical school at the University of Minnesota in Minneapolis.

Congratulations to **Chris Dorn** on her autumn wedding! . . . **Janet Zahradnik** finished a master's at MIT and is now studying medicine at Boston University School of Medicine.

The next LIP-NOSE party is October 21—more news is on the way! Write me a letter so I can let your classmates know what's up!—**Stephanie Levin**, secretary, 41 Prentiss St., Cambridge, MA 02140, (617) LIP-NOSE or (617) 547-6673

88

The past few months have been like a dream come true—I've received a lot of exciting mail. Thanks to all who've written.

Marriage news: **Laura Grunbaum** and **Garly Waldman** were married in August. **Dara Norman**, **Audra Noel**, **Carol Walmann**, **Suzzy Soffler**, **Nazhin Zarghamee**, **Shir Filler**, **Karen Cianciulli**, **Adam Schwartz**, **Alan Sbarra**, and **Jason Dunham** attended the wedding. **Jim "the JEP" Pierce** was planning on attending, but was (still is?) in Yugoslavia rowing on the U.S. National Lightweight Crew Team! However, Laura says they had enough rowers to field their own wedding team.

Shari Berkenblit became Mrs. **Shari Zagorski**, also in August 1988. They honeymooned in New Zealand and Australia. Shari is currently doing research on the auditory system at the Eaton-Peabody Lab of the Mass Eye and Ear Infirmary. . . . **Stacy Mann** married John Leonard, '89, also in August. Congratulations to one and all!

Thanks to **Hanson Cheah**, for the PBE update:

Anton Briefer married Janet Piehl (Wellesley, '88) in October. He was the first one of the '88 brothers "to go," as Hanson put it. . . . **Raju Rishi** is engaged to Patricia Obal, '89. Marriage date is not set yet. . . . Raju finished an MS in Course 3 this past December. . . . Hanson is working for Sun Microsystems in sunny California. He works in the Specials Engineering Group as a mechanical design engineer. They design and manufacture customized Sun products per customer request. He is sharing a house with **Antoine "the Swiss" Firmenich** and two other Stanford grad students. Antoine is in Stanford Medical School's Biochemistry Department working very hard for a PhD.

Karim Roshd is working for Oracle Corp. and is living in a studio next door to Hanson and Antoine. **Mike Hou** completed a master's in electrical engineering at MIT this past December with an AT&T Fellowship. . . . **Chris Thorman** is working at Apple as a futurist in Cupertino, Calif. . . . **Basil Horangic** finished an SM in operations research at MIT in December and was moving on to the University of Chicago for an MBA and PhD in the economics program and also for the "jazz and blues." . . . **Hoang Do** is working in Homdel, N.J. for AT&T. . . . **Moshin Lee** is working on his PhD in mechanical engineering at MIT. . . . **Erick Rizzoto** finally graduated and is working for Monitor in Cambridge, Mass. He will be (already has?) heading to Los Angeles soon.

Stylianios Platakis is working in San Mateo, Calif. for Oracle. . . . **Suresh Thiruganman** is working for DEC in Massachusetts. **Jin Suk Oh** is working on a PhD in mechanical engineering at the MIT AI Lab. He is marrying his hometown (Seoul, Korea) sweetheart in October next year. . . . **Sharmani Nathan** is attending law school at the University of Georgia. . . . **John Zink** is working for Hewlett-Packard in San Diego. . . . **Melissa Nieto** is working for Jet Propulsion Lab in Pasadena, Calif.

Kenneth Yeung finished his 6A and is working at Sun Microsystems. . . . **Corrina Fu** and **Andrew McAfee** are finishing (have finished?) the Leaders in Manufacturing Program at Sloan. . . . **Greg Belaus** is at Adobe in Silicon Valley. . . . **Craig Cohen** is also working for Sun Microsystems. Hanson promised me that you would compile a list of the '88 TDC brothers. . . . (I'll be looking forward to hearing from you).

Darrell Mavis is a second-year student at Harvard Law School. . . . **Alexandra Page** is a second year student at Harvard Medical School. She misses MIT and the MIT way of thinking (you're not the only one!), but is "finally figuring out how to deal with being a Harvard student." . . . **Kamran Badizadegan** was among 47 medical students across the country to receive research training fellowships under a new program begun by the Howard Hughes Medical Institute. . . . **Michelle K. Lee** is at Stanford University. . . . **Catharine Conley** is in grad school in plant biology at Cornell University. She was awarded a three-year National Science Foundation Fellowship for graduate study. . . . **Eugene Sullivan** is a grad student in electro-optics at Tufts University. He is going for a master's.

Tupper Hyde has graduated with an MS in astro/aero from Stanford. He spent the summer in South Africa with Laura Highstone (Wellesley, '88). . . . **William Bayer** is working at Motorola designing the next generation of cellular phones. He hopes to be traveling to Europe on business. . . . **Nitesh Shah** has been working as a mechanical engineer for Hercules Aerospace Division in Vermont since graduation. In the fall of 1989, he started attending the University of Arizona to pursue a PhD in physics. . . . **Christopher Sklarin** is working as a software engineer for Stratus Computer in Marlboro, Mass. He and his wife, Beth, are living in Arlington.

Michael Donohoe is an associate mechanical engineer at Otis Elevator Co. . . . **Charles Animalu** is working with a computer design group at the Anambra State University of Technology (in Nigeria). He is designing tele-

communications equipment for the Nigerian Telecommunications company. . . . **Mark Shudt** is doing R&D work on a space-based interceptor for SDI at a Los Angeles Air Force Base. . . . Marine 2nd Lt. **Stephen Herrera** is with the 2nd Marine Division, Camp Lejeune, N.C. . . . **Dave Saslav** is working at IntelliCorp in Mountain View, Calif. He is "LILLOVING it." . . . **Eugene Ciccarelli** is also at the same company. . . . **Kenneth Graves** and **Leonard Schulman** are the newest members of the American Mathematical Society. . . . **Jeff Silver** was awarded an NSF Graduate Fellowship.

Craig Jungwirth is living his dream, jetting between Orlando and Paris, working on the Euro Disneyland. He writes with news about many of our classmates. . . . **Andy Vyrros** landed a job with a small electronic graphics/animation firm in San Francisco after taking a cross-country motorcycle trip and flying back and forth between the two coasts a few times. . . . **Cindy Closkey** is working for a PC-based expert systems company in Cambridge. . . . **Julian Macri** is at IBM in Charlotte, N.C. . . . **Tom Clune** is "cruising right along" at UC/Berkeley in the physics program there. He is/has been/will be rooming with **Vin Crespi**. . . . **Sharon Weber** is still working for DEC in Northboro, Mass. . . . **Simone Tsigonis**, after graduating from architecture in December 1987, returned to the graduate program in the fall of 1988. She has also been very busy with her internships.

Becca Munroe is working at Kodak in Rochester, N.Y., in the Leaders in Manufacturing Program. . . . **Sean Garrett**, after finishing his EIP in DEC in Colorado Springs, is working for Bose and living on Beacon Hill in Boston. . . . **Frank Kulbaski III** is at Cornell Law School. He says law school is a breeze relative to MIT. (In answer to your question Craig, an emphatic *no*—med school is not a breeze relative to MIT). . . . **Pat Maier** is with a company called Transitions Research Corp. in Danbury, Conn. TRC makes mobile autonomous robots. . . . Craig extends a personal invitation to any class of '88ers visiting Orlando to give him a call, drop him a line, or stop by his offices when you're in one of "his" parks.

I enjoyed reading all your letters and hope you've enjoyed reading about your classmates. Keep up the good work!—**Grace Ma**, secretary, 435 E. 30th St., New York, NY 10016, (212) 689-8780

89

There is a lot of news to report now that more people are settled into their new locales. I haven't received a whole lot of mail, but I suppose that's because no one has seen the first "call for cards." I hope reading the news this month might inspire you to send those cards or letters! Don't forget that the Alumni Office makes the locations of all alumni available to other alumni. If you need to find someone, it is a good place to call; so be sure that they have your current address so other friends might be able to find you.

Married last June 3 were **Amy Bourassa** and **Greg Tashjian**. They are living in San Francisco where Amy is attending med school at USF and Greg is attending Stanford. . . . Also married in June were **Eileen Krolkowski** and **Eric Koefoot**. . . . In July **Veronice Stassen** and **Tom Bartman** were married.

In the MIT scene, **Claudio Chamon** is back for grad school in Professor Fujimoto's group. Claudio spent the summer at East Campus working with an MIT program for high school students. . . . Finishing VI-A are **Ari Dimitriou** and **Ken Streeter**. . . . Finishing VI-A at Lincoln Labs is **Thoa Nguyen**. . . . **Rosina Samadani** is also back, living with **Sumitha Bellam**, who is working in the area.

Scott Deering is now a floor tutor at Next House. . . . **Michael Ernst**, **Harry Hochheiser**, and **Derek Chiou** are in the Computer Science Department. Derek is now living in a large three-

family house in Central Square with **Venu Chivukula**, **Ronald Koo**, and some other MIT grad students. . . . **Andy Barrows**, **John Araki**, and **Ben DeSousa** are living near Copley. John and Andy are in the Aeronautics and Astronautics Department.

Tali Tamir is now an admissions counselor at MIT, where she has also been helping with Sigma Kappa. . . . Almost as close to MIT without working there are **Amy Austria** and **Nancy Kim**; both work at the Cambridge Technology Group on Vassar Street and are living together in Boston.

Aaron McPherson has been working to save the Coolidge Corner Theater from some developers by raising money to turn the theater into a multi-arts complex. . . . **Leslie Lin** is at Harvard studying physics, while **Eric Reifschneider** is at Harvard Law School.

Around the Boston area, **Catherine Rocchio** is working for BBN, and **Julie Lee** is working at LEK. . . . **Rich Lightburn** is working for Goldman Sachs in Boston, where he lives with **John Krsak** and **Mike Petro**. . . . **Brian Pan** and **Eric Tang** are working for Raytheon. . . . Our class president freshman year, **Chris Armentrout**, is working for GE in Lynn. . . . **Risa Bobroff** is at HP, also in Massachusetts.

About as far from Boston as you can get, **Rick Osgood** is in Russia working with some physicists. . . . **Christina Ko** is working for Citibank in Hong Kong. . . . **John Allen** is in Japan working for Nissan. . . . Also in Japan are **Angelina So** and **Renee Oatway**.

Miky Ishida is working for an architecture firm in New York City before going back to grad school. . . . Among other classmates in New York are **Carolyn Zehner** at JP Morgan, **Christine LeViness** at Arthur Andersen, and **Jackie Berger** at the Federal Reserve Bank. . . . **Yang-Ki Kim** is working at First Boston. . . . **Bernard Lee** is working at IBM in East Fishkill, N.Y. On the drive out from his home in California, he stopped to visit **Mike Chung**, who is in med school in Ohio.

Jennifer Lund and **Jim Kosloski** are at the University of Michigan. Jennifer was recently elected to serve a five-year term on the MIT Corporation. Since starting school, she has traveled back to MIT several times. . . . **John Bryan** is in med school at the University of Galveston. . . . **Suephy Chen** and **Gigi Hamad** are in med school at Johns Hopkins. . . . **Lisa Shane** is at Carnegie-Mellon. . . . **Andre Castagna** is at RPI.

David Schulman writes from the University of Florida's Physics Department, where there are several other MIT alumni: **Mike Jones**, '86, and Professor Lennart Peterson, '66. David remarks that UF is "too huge" with 42,000 students.

Bruce Horton is at Yale, and **Paul Chow**, **Mike Lam**, **Dickson Cheung**, and **Vince Chau** are at Northwestern. . . . **Tom Powers** is at U Penn. . . . **Dan Canady** is at U Chicago working with a professor who recently came from MIT. . . . Also working there is **Marlene Lamas**.

Laura Brauer is working for GE in Pennsylvania. GE will soon be sending her to study at Rutgers. . . . **Kevin Maschetti** has started an MIT club in Washington state and is now the president of the club. . . . **Dawn McKinley** is working in Washington, D.C., for the National Cancer Research Institute. . . . **Alan Davidson** is working at Booz, Allen, Hamilton in Washington, D.C., where he is working on the space station. . . . **Roger Claypool** and **Teri Centner** are stationed at Wright-Patterson Air Force Base in Dayton, Ohio. . . . **Christine Chen** is working in Cincinnati for Proctor and Gamble.

James Yao is in San Francisco working for Oracle. . . . Also working at Oracle is **Eugene Wilson**. . . . **Suzanne Wurster** is also working in the San Francisco area. . . . On the West Coast for school are **Lisa Tokumaru** at UCLA for architecture and **Alison Miyamoto** at Stanford.

That's all the news I have for now; don't forget to send those letters! Thanks, and have a great year.—**Henry Houh**, secretary, 5380 Hollow Dr., Bloomfield Hills, MI 48013



COURSE NEWS

I CIVIL ENGINEERING

Deborah L. Thurston, PhD '87, is an assistant professor at the University of Illinois at Urbana-Champaign. She recently received a Presidential Young Investigator Award from the National Science Foundation to explore the interface between operations research and artificial intelligence. . . . Tufts University Associate Professor **Lewis Edgers**, PhD '73, has been elected president of the Boston Society of Civil Engineers (BSCES)—the oldest engineering society in the country, founded in 1848. A member of the American Society of Civil Engineers and the International Society of Soil Mechanics and Foundation Engineering, Edgers is also the Tufts representative for the International Association of Drilled Shaft Contractors and the Transportation Board of the National Research Council.

II MECHANICAL ENGINEERING

Nathan M. Stelman, SM '88, sends word that he has joined Robotic Development, a consulting and systems-integration firm in the manufacturing automation field. Their first product, a high-speed, high-accuracy Cartesian robot for fine-pitch SMT placement, was well received when introduced at a West Coast electronics manufacturing show this past March. Now evolving from prototype to production models, it has attracted considerable attention (and several orders) from one of the largest computer manufacturers in the United States. Their first year draws to a close with the delivery of a vision-based inspection system to a client in the biotech area and a move to larger quarters as they expand from three to five employees. . . . **Richard H. Johnson**, SM '80, is now at Allen-Bradley in Highland Heights, Ohio, as manager of strategic marketing programs. . . . **James G. Hannoosh**, PhD '75, was appointed president of Cerbec Ceramic Bearings Company in 1988. "Cerbec is a joint venture between Norton Co., a leader in advanced ceramics, and Torrington Co., America's largest broad-line bearing producer," he writes. "Ceramic bearings utilize silicon nitride ceramics. They generally outperform steel bearings in all technical areas."

In two separate ceremonies, **John H. Sununu**, '61, was the recipient of distinguished honors. The first ceremony, held at the White House in April, was from ASME. The former New Hampshire governor and current chief of staff to President Bush was presented a certificate marking his election as a Fellow of ASME. During the ceremony, ASME President Ernest L. Daman noted, "His goal and method have remained the same as both an engineer and as a politician: to better the life of his fellow man through the use of the same systematic and logical problem-solving approach so natural to engineering." ASME News notes that Sununu's elevation to the grade of Fellow was approved before his move to Washington. At the second ceremony, held in September in Toronto, Ontario, the American Society for En-

gineering Management honored Sununu as Engineering Manager of the Year for 1989. "This award is presented annually to the engineer who best exemplifies the ASEM precepts and concepts of effective management in their career," the society said in a news release. "Throughout his nearly 20 years of service as an educator, engineer, small businessman, and community leader, Sununu has exhibited outstanding leadership and management skills."

Henry (Hank) Montrey, SM '82, has been named director of the USDA Forest Service's Rocky Mountain Forest and Range Experiment Station, headquartered in Fort Collins, Colo. In his new assignment, Montrey will oversee forest and rangeland research at seven laboratories throughout a 10-state region. He comes from the agency's Forest Products Laboratory in Madison where he has been deputy director since 1986. . . .

University of California, Berkeley, Professor of Mechanical Engineering **Boris Rubinsky**, PhD '81, received the Gustus L. Larson Award from ASME. The award, named after a past ASME president, is awarded to an engineering graduate who has demonstrated outstanding achievement in mechanical engineering within 10 to 20 years following graduation. Rubinsky is widely known for his work in low-temperature biotechnology. He developed a new technique for the treatment of cancer using freezing monitored by ultrasound, used in the clinical treatment of inoperable tumors in the liver and in other organs. He has founded two companies, Strategic Yields and Cryosurgical Instruments.

III MATERIALS SCIENCE AND ENGINEERING

Anton Brasunas, ScD '50, is teaching corrosion principles to industry people via the National Association of Corrosion Engineers and other sponsors. He was elected national secretary of the U.S. Metric Association and several years ago received a Fulbright Award to teach metallurgy at Antioquia University in Medellin, Colombia. . . . From Rochester Hills, Mich., **John F. Watton**, ScD '87 writes, "I have been appointed associate professor of mechanical engineering at Lawrence Technological University in Southfield, Mich., with the

responsibility of developing a new graduate program in manufacturing engineering." . . . After five years of R&D work and several awards for his contributions, **Nun-Sian Tsai**, PhD '83, recently left his MTS position as group leader in the VLSI Technology Lab at Bell Labs. He is now employed as deputy director to the R&D Dept. of Taiwan Semiconductor Manufacturing Corp. and has plans to teach at National Tsinghua University. . . . **Michael K. Korenko**, ScD '73, has been promoted to vice-president of Westinghouse Hartford Co., overseeing its Engineering and Development Divisions. In his new position, Korenko will direct the company's four energy-related divisions and his responsibilities will cover all major non-defense operations managed at the DOE's Hartford Site in Washington State.

Matthew J. Donachie, Jr., ScD '58, staff project engineer of materials engineering, Pratt & Whitney, East Hartford, Conn., and **David E. Laughlin**, PhD '73, Department of Metallurgical Engineering and Materials Science at Carnegie-Mellon University, Pittsburgh, Penn., have been named Fellows of ASM International, the advanced materials society. Donachie has been selected "for a continuing commitment to materials education and significant contributions to superalloy development by application of computer techniques" and Laughlin "for outstanding research and teaching achievements in continuous phase transformations as they affect microstructure, properties, and their respective phase diagrams." At the society's October 3rd Awards and Annual Dinner, **Donald J. Blickwede**, ScD '48, retired vice-president and director of research for Bethlehem Steel Corp., Bethlehem, Penn., was named an honorary member of ASM International, its highest award. He was cited "for an outstanding career in research, research management, and corporate technical guidance, and for unstinting contributions to the profession via national academies, research institutes, and ASM International."

The Alumni/ae Association has received word of the death of **Howard R. Spendelov, Jr.**, ScD '42, in 1987. No further information was provided.

IV ARCHITECTURE

Rebecca A. Allen, SM '80, is teaching computer graphics and animation in the Design Department at UCLA and is an independent designer and director for projects involving new media technology. . . . **James F. Heiberg**, MAR '79, is now an associate at Olson Lewis Architects & Planners, Inc., in Manchester, Mass. He was the project architect for the Royal Sonesta Hotel expansion in Cambridge, the new conference center at the Lafayette Hotel in Boston, and the Cherrystones restaurant in Boston's North End. . . . **Rod Brana**, SM '86, and his wife, Monica, are the parents of Nicholas Alexander, born July 5, 1989. . . . **Belinda Walters**, SM '86, has been promoted from project manager for finance to assistant project developer at Forest City Development's University Park at MIT. University Park is the largest mixed-use development in Cambridge.



M.K. Korenko

Russ Van Vleck Bradley, Jr., MAR '71, reports that his life has changed significantly in the past few years. He married Catherine Biner of Switzerland in May 1988, and their daughter Julia was born a year later. The family lives in Geneva, where Russ is counsel to the law firm Bourquin & Biner Bradley, run by his wife and a former professor of business law at the University of Geneva. Russ handles the international and U.S. angles, as Swiss law is sufficiently different from American law that he would need to start law school all over again to practice it. Twelve years ago when he was a first-year student at Harvard Law at age 35, writes Bradley, he was (approximately) the prototype for "Aubrey Drake," the older, conservative type in Scott Turow's *One L*, but I was not so conservative and was, of course, a former architect and not a failed gallery owner."

Moreland Griffith Smith, MAR '33, died at age 82 of heart failure on June 26, 1989, in Atlanta, Ga. He was a founder of Sherlock, Smith, and Adams Architects and Engineers in Montgomery, Ala., a firm he sold to his partners in 1965 after "drawing the wrath of Montgomery segregationists and then-Gov. George C. Wallace over support of blacks and his request to the mayor for fairness in the seating of blacks on city buses," according to his obituary in the *Atlanta Journal*. His activism, which began in 1954, included service on civil rights committees and as a trustee for many years at Tuskegee Institute; that and his efforts to hire black architects and propose them for membership in the AIA led to Wallace's attempting to prevent his firm from getting architectural jobs, and a bank declining to extend the firm's line of credit. Smith moved to Atlanta when he left his firm and joined the staff of the Southern Regional Council, doing some architectural consulting work on the side. He was honored by the Atlanta chapter of the AIA two years ago "for his conviction and courage during the tumultuous early years of the civil rights movement." Smith was a major in the Army Corps of Engineers in England during World War II. He was a Fellow of the AIA, a former president of its Alabama chapter, and the treasurer general of the National Society of Mayflower Descendants.

The Alumni/ae Association has been notified of the death of Robert G. Emerson, MCP '49, on July 26, 1989, after a lengthy illness. He resided in Bay Head, New Jersey; no other information was provided.

V CHEMISTRY

Rensselaer Polytechnic Institute has announced the appointment of G. Doyle Daves, PhD '64, as dean of its School of Science. Daves, a researcher specializing in the design and synthesis of potential drugs to treat AIDS and cancer, was professor of chemistry at Lehigh University until he moved to RPI. . . . MIT Professor of Chemistry Robert A. Alberty was elected vice-president of the Physical Chemistry Division of the International Union of Pure and Applied Chemistry at the meeting of the organization's general assembly in Sweden. . . . Philip E. Rakita, PhD '70, was appointed manager of the Bio/Fine Chemicals Department at M&T Chimie in Paris. . . . Max G. Sherer, SM '43, reports on his two sons: Daniel received an MA in history from Cambridge University, with his father in the audience, and now goes on to work on a PhD at Harvard with a fellowship in art history; David is an anaesthesiologist in Maryland after finishing his residency in Miami.

Richard H. (Pete) Farmer, SM '36, died on June 4, 1989, in Marco Island, Florida. A native of Alberta, Canada, he had lived for 27 years in Virginia Beach, Va. During the course of his career as a chemical engineer, Farmer worked as superintendent of uranium operations for the Eldorado Mining and Refining Company at Port Hope, Ont., superintendent of Coronet Phos-



D.P. Reed

phate at Plant City, Fla., manager of Texas City Chemical Co, director of research and production manager of Borden Chemical Co., and president of Illinois Nitrogen Corp. He was a member of the American Institute of Chemical Engineers and a life member of the Canadian Institute of Mining and Metallurgy. . . . John C. Morrow III, PhD '49, died on July 21, 1989, in Chapel Hill, N.C. He was provost of the University of North Carolina at Chapel Hill from 1968-84, dean of the General College and the College of Arts and Sciences for two years before that, and a chemistry professor since joining the faculty in 1949. In 1985, the university selected Morrow to receive the Thomas Jefferson Award, given annually to the member of the UNC community who best exemplifies the ideals and objectives of Thomas Jefferson. After retiring as provost, Morrow returned to teaching and research; in part as a result of a sabbatical leave at the Technical University in Berlin, he developed an interest in the structure and reactivity of molecular ions. Other research interests included X-ray crystallography and magnetic and thermal properties of solids.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Robert A. Iannucci, PhD '88, is now managing the "Hybrid Dataflow Systems" group at IBM's T.J. Watson Research Center. The group is pursuing the synergistic combination of dataflow architectures, developed at MIT and elsewhere, and the more traditional von Neumann family of architectures for parallel computation. . . . Cecelia E. Henderson, SM '82, reports that she started Carlson Publishing Co. in 1983 with two partners, and then in 1987 started Blind Moth Books & Drinks to sell books, coffee, tea, and cocoa. Her book specialties include technical, business, and children's. "Special orders welcome," she says. . . . Formerly general manager of Hewlett-Packard's Andover Division, David M. Perozek, EE '67, is now general manager of H-P's Apollo Division in Chelmsford, Mass. . . . Einar Greve, SM '53, has resigned as chairman, president, and CEO of the Tucson Electric Power Co.

Guy L. Steele, Jr., PhD '80, a senior scientist at the Thinking Machines Corp., received the 1988 Association for Computing Machinery's Grace Murray Hopper Award. Steele was cited for his contributions to the development of higher-order symbolic programming, "principally for his advancement of lexical scoping in LISP." He has written reference books on LISP and C, and has published many technical papers on the LISP language. At Thinking Machines, Steele is responsible for the design and implementation of parallel programming languages and other systems software for the Connection Machine. The award recognizes young scientists who have made outstanding contributions to the computer industry while 30 years old or younger.

Jerry Ladd Prince, PhD '88, has been appointed an assistant professor at The Johns Hopkins University. Since early 1988 he worked as a research scientist for the Analytics Sciences Corp.

in Reading, Mass. He specializes in signal processing with an emphasis on medical imaging, nondestructive testing, and computer vision.

Pennsylvania State University has announced that William E. Leonhard, SM '40, president and CEO of The Parsons Corp. in Pasadena, is one of two people named 1988 PSU Alumni Fellows. The title is a lifelong designation, and brings with it an invitation to lead seminars at Penn State and visit with students and faculty. Leonhard was also the 1989 commencement speaker for PSU's College of Engineering. . . . David P. Reed, '73, vice-president of Lotus Development Corp.'s Software Products Group, has been appointed chief scientist for all spreadsheet-based products. Reed was a chief architect for 1-2-3 Release 3, pioneered the creation of 3-D worksheets, and was responsible for initiating the Lotus Extended Application Facility. He also was a major contributor of DataLens, a new Lotus technology that allows users to link directly with a wide range of external data sources. . . . Max V. Mathews, ScD '54, a professor at Stanford who developed one of the first electronic musical synthesizers, has recently patented a new invention: an electronic pickup for the violin and other stringed instruments to amplify sound. Unlike conventional pickups, which are electromagnets that create electrical pulses in response to the vibration of strings in their magnetic fields, Mathews' device is made of ceramic and is embedded in the bridge of the instrument where the strings are attached. When a string bends back and forth as it vibrates, it stimulates a resonant pulse in the ceramic. According to an item in the *New York Times*, the invention is more sensitive than existing pickups to a much wider range of frequencies and relays the sounds more faithfully.

Northeastern University Professor Emeritus of Electrical Engineering Laurence F. Cleveland, SM '35, died of cancer on July 16, 1989; he was 84 years old. During the 44 years he was a faculty member, Cleveland served as acting chairman of the Electrical Engineering Department, director of the Power Systems Engineering Program, and faculty advisor to the Choral Society and fraternities Tau Beta Pi, Sigma Phi Alpha, and the national Electrical Engineering Honor Society. Eta Kappa Nu Association named the university's power lab after him. He retired from Northeastern in 1973. The Boston Chapter of the Power Engineering Society honored him as the first recipient of the Laurence F. Cleveland Award given annually to a local electric power engineer for contributions to the industry.

VI-A INTERNSHIP PROGRAM

As this is being written in late September, our VI-A undergraduates are back on campus from their nationwide summer assignments and our new freshmen are quickly getting acclimated to MIT. With few exceptions the reports on this summer's VI-A Company Assignments were excellent.

The New England area has been experiencing fall weather earlier than usual this morning, as I write, Mt. Washington reports wind gusts to 118 mph with snow! The *Old Farmer's Almanac* tells us to expect a "White Christmas" this year. Last year the winter came and went without a major snowfall in the Boston area.

Enrollment in VI-A currently stands at 253 (it was 250 a year ago). This year's Course VI sophomore class stands at 275 (down from 332 a year ago). The incoming freshman class numbers about 1050, slightly above the recent classes of 1000, even though the number of applications received was down by 10% (quality was higher, though).

Last month I reported on the fine time I had renewing alumni/ae acquaintances on my swing from Dallas to the San Francisco area. Since returning, several alums have come by the VI-A Office and notes have been received. I'll cover

these alphabetically.

An announcement from **Eric W. Burger**, '84, and wife Deborah, proclaims the arrival of daughter Rachel Marie Wanda on 19 August 1989. Their address is given as Kessel-Lo (Belgium). Eric had been a senior software engineer with Valid in San Jose, Calif., the last I heard.

I know of one other VI-A living in Belgium (Brussels), **Lester A. Gimpelson**, EE '61. Lester was with IIT and is now a consultant, retired and still living there.

Yonald Chery, currently in the graduate phase of VI-A, is serving as assistant to the director of Program XL at the Institute. This is a new voluntary program for freshmen administered under the Office of Minority Education (OME) and consists of small study groups in math and physics, six units of credit, a lecture series entitled "You Can Be a Success at MIT" and a recommended credit limit of 54 units. If Program XL is oversubscribed, preference is given to underrepresented minorities.

I received an invitation to attend the October 28th wedding of **David K. Gerber**, SM '85. Dave is currently a captain in the U.S. Air Force. He has been stationed in Bitburg, Germany, following completion of Pilot Training and graduation at the head of his class. We wish him much happiness in his marriage.

Arthur T-C Hu, SM '81, likes to write and has done so often in *The Tech*, expressing his views on many topics. He recently "hit the jackpot," in terms of reader coverage, with a letter to the syndicated columnist Ann Landers presenting his observations against the feeling that "the world is going to hell in a handbasket." Art describes himself as a "neo-conservative."

L. David Passmore, SM '78, and **Siddhartha Banerjee**, SM '88, came by for a visit while in Boston. They, along with **Joseph L. Healey**, '76, had formed a company involved in networking that was bought out by Ernst & Young. Dave is now a partner with that firm and Sid a senior consultant. Joe is currently representing them in Holland.

People ask me where the "half-time" comes into my schedule, now that I'm technically retired. So far I've enjoyed continuing my affiliation with the VI-A Office and the satisfaction of continuing my alumni associations which allow me to keep up this section for *Technology Review*. Keep in contact!—**John A. Tucker**, Director (Emeritus) VI-A Internship Program & Lecturer, MIT, 77 Mass. Ave. Rm 38-473, Cambridge, Ma 02139.

VIII PHYSICS

Thomas B. Lewis, PhD '65, has been named senior vice-president and COO of Celgene Corp., Warren N.J. Most recently, he was the company's vice-president of marketing. . . . **Elsa Garmire**, PhD '65, has been elected to the National Academy of Engineering. She is professor of electrical engineering and physics and director of the Center for Laser Studies at the University of Southern California. . . . **Greenfield Community College**, Greenfield, Mass., has named **Ira Rubenzahl**, PhD '71, assistant dean for the natural science, math, business and nursing grouping. He has been teaching math and physics at the college since 1976. . . . **Lawrence M. Krauss**, PhD '82, associate professor of physics and astronomy at Yale University and visiting professor at the Harvard-Smithsonian Center for Astrophysics, has written *The Fifth Essence: The Search for Dark Matter in the Universe*. A tentative publication date was early December 1989 by Basic Books, Inc.

John W. Crawford, Jr., SM '50, is one of five veterans of the nuclear industry nominated by President Bush to a new regulatory board created by Congress to oversee the Energy Department's troubled nuclear weapons production facilities. A retired U.S. Navy captain, for many years he served in the Naval Nuclear Power Program under Admiral Rickover, including assignment as

deputy manager, Naval Reactors. Later, he held key positions in the government's civilian reactor development program, including principal deputy assistant secretary for nuclear energy, Department of Energy. Crawford was awarded a commendation medal by the secretary of the Navy for contributions to construction of the first nuclear-powered aircraft carrier, USS *Enterprise*, and the exceptional service medal of the DOE.

X CHEMICAL ENGINEERING

Ray N. Levitch, ScD '66, writes, "After an 'odyssey' of six-plus years with assignments in Phoenix and New York, we're now back in Houston full-time, where I'm planning advisor in Shell Oil's Corporate Planning Department. My wife, Janine (a former Course X Techretary), and my three sons are doing fine. Work brings me back to Tech often to visit the Center for Energy Policy Research." . . . (**Charles**) **Ken Walker**, SM '40, "recently moved to the wide open spaces of Oregon, more specifically Medford. We would welcome visits from MIT classmates."

Among several new vice-presidents named recently by the Greater Boston Chamber of Commerce is **Samuel W. Bodman**, ScD '65, chairman and CEO of the Cabot Corp. . . . **Albert S. Humphrey**, SM '49, chairman of the London-based Business Planning & Development, Inc., was recently elected director of two firms as a result of his experience with team management. According to a BP&D press release, Humphrey was selected by Long Life Herbal Products, Inc., of Basking Ridge, N.J., and Visual Enterprises Ltd. of London, for his use of a "unique team approach to business development called 'Team Action Management' (TAM), which is an advanced version of the Japanese 'Quality Circles.'" Humphrey also is a director of International Candle Co. Ltd., Electra Screen Ltd., and Sanbros Ltd. . . . **Bing H. Ko**, ScD '84, has joined the internal medicine practice of Martin Fenton, MD, in Medford, Mass. Although Ko's initial interest was in research, he says, "The time I spent earning my doctor of science degree at MIT while I was completing my residency really helped me to compare research with direct patient care. As I began to experience increased contacts with patients, I began to realize that patient care was something I wanted to devote my life to."

Edward A. Mason, ScD '50, recently retired senior vice-president of technology at Amoco Corp., was named a Fellow of the American Institute of Chemical Engineers (AIChE). The council cited the Osterville, Mass., resident for his outstanding achievements in chemical and nuclear engineering education and research. Also honored was **Christian W. Knudsen**, ScD '69, president of Carbotech, Inc., in Houston. He was cited for his expertise in process development of synthetic fuel plants, chemical processing plants and thermal-enhanced oil-recovery processes.

Robert E. Latimer, '46, died on June 29, 1989, at his home in Plainfield, N.J., after a year-long battle with cancer.

XI URBAN STUDIES AND PLANNING

When **William A. Cawley**, SM '55, retired from the U.S. Environmental Protection Agency, he received the Distinguished Career Award for "an outstanding and exemplary career in providing direction and leadership for the United States of America and the EPA in the advancement of pollution control technology and management practices."

Henry G. Cisneros, '74, current chairman and CEO of Cisneros Asset Management Co., has been named a director of Interlogic Trace, Inc., in San Antonio, Tex. . . . **Pui-Leng Woo**, MCP '82, has been named an associate at Ellenzweig Associates, Inc., a 60-person architectural firm

Bromberg & Sunstein

Counsellors to technology based businesses in areas including intellectual property law (patent, trademark, copyright, trade secret), unfair competition, corporate securities and financing, licensing, and litigation.

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Systems integration
Test design



H.B. Bluestein

R.C. Buehner

in Cambridge.

In San Francisco, **Paula R. Collins**, MCP '75, has been appointed to the board of trustees of Pacific Presbyterian Medical Center. She is a founder and principal share-holder of the Western Development Group, Inc., in San Francisco and currently supervises commercial, industrial, and residential land-development projects. She was the assistant project manager for the \$100 million Moscone Convention Center in downtown San Francisco. . . . **Anthony W. Caner**, SM '85, has been appointed project manager at Equity Ventures, Inc., a real-estate-development firm in Warwick, R.I. His responsibilities include the Lincoln Center Office Park, a 1-million-square-foot suburban office development in Lincoln, R.I., a joint venture between Amica Mutual Insurance Co. and Equity Ventures. As a project manager at Neelon Cos. before joining Equity Ventures, Caner had been director of redevelopment of the 850,000-square-foot Hingham Shipyard.

XII EARTH, ATMOSPHERIC AND PLANETARY SCIENCES

Howard B. Bluestein, PhD '76, an associate professor of meteorology at the University of Oklahoma, has been named the 1989 Oklahoma Professor of the Year by the Council for Advancement and Support of Education (CASE). Bluestein, a pioneering researcher and "tornado chaser," was also honored in early 1989 with the OU Regents Award for Superior Teaching. In 1988 he received an Associates Distinguished Lectureship and the OU Student Association Outstanding Faculty Award in the College of Geosciences. According to a press release issued by the University of Oklahoma, Bluestein's students cite his expertise, sincerity, humor, and friendliness as qualities they admire most. A colleague credits him with doubling the school's undergrad enrollment in meteorology and drawing more out-of-state residents than any other degree program. . . . **John P. Jemsek**, PhD '88, is an hydrologist at an engineering firm in New England.

John A. Brown, Jr., SM '57, died on July 16, 1987 in Waldorf, Md. He was chief of the National Meteorological Center's R&D Division, and was recognized internationally as an expert in using computers to model and predict the weather. Brown had won many awards for excellence in atmospheric science and administration of research programs, including the American Meteorological Society's Charles L. Mitchell Award, and was elected a Fellow of that society in 1973. . . . **Parker N. Chick**, '47, died on July 22, 1989, in Cambridge. He was 84 and a resident of Chatham, Mass., and Naples, Fla. During World War II, Chick was an instructor in meteorology at MIT. Subsequently he became a financial investment broker.

XIII OCEAN ENGINEERING

Dimitris Petrongonas, SM '76, is a partner and technical director of KP & Associates, Ltd., naval

architects, marine engineers, surveyors, contractors, and ship designers. The company was established in 1988 after he retired from the Hellenic navy with 26 years of service. He is a member of the Hellenic Chamber of Shipping, and the Technical Chamber of Greece, among other institutions and societies. . . . **Michael R. Reed**, OCE '76, married Linda H. Grindell on July 21, 1989, in Bath, Me. He is a commander in the U.S. Navy stationed at the Naval Sea Systems Command in Washington, D.C., as director for Advanced Surface Ship Machinery Systems development and director for the Ship Systems Engineering Management office. Reed has additional duty as project officer for Advanced Machinery Systems at David Taylor Research in Annapolis, Md.

The Alumni/ae Association has received word of the death of **Capt. William C. Sprenger**, SM '32, USN (Ret), on April 16, 1989. No further information was provided.

XIV ECONOMICS

Yale Professor of Economics **William D. Nordhaus**, PhD '67, has been named to a study panel on Policy Implications of Greenhouse Warming commissioned by the EPA at the request of Congress. The panel, under the auspices of the Committee on Science, Engineering, and Public Policy (a unit of the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine), is expected to prepare a report by the end of 1990. . . . **Nicholas S. Perna**, PhD '69, has been promoted to senior vice-president from chief economist at the Connecticut National Bank in Danbury.

Richard Snyder, PhD '53, died on May 28, 1989, in Bangor, Me., of complications following surgery for an abdominal aortic aneurism. An expert in social psychology, Snyder was one of the architects of the U.S. Department of Education's Follow Through Program designed to build on the learning experiences of Head Start children. Earlier, he had been a member of the Human Research Unit of the Presidio of Monterey, Calif., pursuing his primary interest in educational research and development, and then assisted the University of California at Santa Cruz in academic planning and curriculum development when that campus was being established.

XV MANAGEMENT

Jay R. Petschek, SM '82, and his wife, Marybeth, had their first child, Andrew Jay, in December 1988. Jay is managing director of corporate finance at Ladenburg Thalmann Co., Inc., in New York City, and Marybeth is pursuing a PhD at Columbia University. . . . In Chicago, **Elisabeth G. Houston**, SM '75, has been working for the American Medical Association since 1987. She is now director of the Office of Special Groups, and last spring completed major congressional efforts to expand Medicaid coverage. Houston reports that her son, Joshua Houston Gurian, age 7, wants to attend MIT. . . . At Exxon Coal and Minerals Co. **Robert J. Doyle**, SM '58, has been promoted from general manager of marketing to vice-president of marketing in Houston, Tex. . . . **Neil S. Novich**, SM '81, has moved up to vice-president at Bain & Co. from manager. . . . **Ronald C. Buehner**, SM '62, has been appointed vice-president of manufacturing for Avery International Corp. in Pasadena, Calif. Avery manufactures self-adhesive base materials, labels, tapes, office products, and specialty chemicals.

David Solomont, SM '80, the founder of Business & Professional Software, Inc., was the subject of an in-depth "Executive Interview" in *Mass High Tech* last summer. His firm, which designs software for computer-generated presentation graphics, started off slowly in 1980 while waiting

for the business world to catch up; now it is beginning to, and sales are growing rapidly. . . . In Norwich, Conn., **Richard Wolak**, SM '83, has been promoted from business manager to vice-president of finance of United Community Services. . . . **Roger Guerin**, SM '82, was profiled last summer in the *Maine Times*. He and his wife, Christine, moved back to Maine three years ago from Massachusetts. Roger works for Union Mutual Life Insurance in Portland, and the two have planted two big gardens near their house in North Windham. They have also been joined by Rosemary Rachel, a daughter adopted just over a year ago. . . . An item in the "Friends of MIT Sailing" newsletter thanks **Tom Weld**, SM '88, for giving his 470 to MIT—the boat that won the Olympic Trials in 1984. Notes the newsletter: "There is something special about this donation because Tom was a sailing star for our rival, Tufts University. While doing his graduate work at Sloan, Tom even coached at Tufts; however, when it came time to make this donation, it was to MIT he gave his boat."

Sloan Fellows

Robert J. Schwinghamer, SM '68, was recently named a Fellow of ASM International. He was cited for "outstanding contributions in the field of engineered materials processing techniques and application to advanced space systems." Schwinghamer is the deputy director for Space Transportation Systems, Science & Engineering Directorate, at the NASA George C. Marshall Space Flight Center in Alabama. . . . **William J. Lhota**, SM '78, formerly the president and COO of the Columbus Southern Power Co., is now the executive vice-president of operations at the American Electric Power Service Corp. Both are subsidiaries of the American Electric Power Co. . . .

Philip B. Fletcher, SM '70, is now president and COO of ConAgra, Inc. He was previously president and COO of a ConAgra subsidiary, ConAgra Prepared Foods Co. . . . **James K. Bakken**, SM '63, retired as vice-president in charge of corporate quality at Ford Motor Co. last June. He was recently made a director of Simpson Industries, Inc., in Birmingham, Mich. . . . **A. Thomas Young**, SM '72, was scheduled to become president and COO of Martin Marietta Corp. effective December 31, 1989. Since August he has been executive vice-president of the company; prior to that he was president of the Electronics & Missiles Group of Martin Marietta. . . . **Jerry R. Davis**, SM '76, has been named president of CSX Rail Transport in Jacksonville, Fla. He was formerly the executive vice-president in charge of operations at the Union Pacific Railroad Co. in Omaha, Neb.

Senior Executives

Martin R. Klitten, '88, is now vice-president for finance and CFO at the Chevron Corp. in San Francisco. He was previously president of a subsidiary, the Chevron Information Technology Co. . . . **Thomas R. McCaffrey**, '85, has moved from one subsidiary of American Electric Power Co. to another. Formerly president of the Wheeling Power Co., he is now president and COO of the Columbus Southern Power Co. . . . At another subsidiary, **Richard C. Menge**, '80, has been promoted from senior vice-president to president and COO of the Indiana Michigan Electric Co. in Fort Wayne, Ind. . . . **Richard M. Ornitz**, '85, has changed jobs and locations—from Ridgely Park, N.J., where he was vice-president and general counsel at the Degussa Corp., to Stamford, Conn., where he is a partner in the law firm of Cummings & Lockwood. . . . A former executive vice-president at H&R Block, Inc., in Kansas City, Mo., **Thomas M. Bloch**, '88, is now president and COO. He continues in his capacity as a director. The firm was co-founded by his father, Henry W., who is now chairman and CEO.

At AT&T, **William T. O'Shea**, '87, was named vice-president of the merged product manage-

ment and development area, part of the Computer Systems Unit of the Data Systems Group. He was vice-president of product development for the computer group previously.

The Alumni/ae Association has been notified of the death of **William M. Shorten**, '77, on July 13, 1989. He was an executive director of Barlow Rand Ltd. in South Africa.

Management of Technology Program

M. Amanda Gillum, SM '87, is now director of the Natural Products Biology Department at Sterling Drug, Inc., a subsidiary of Kodak. . . . **R. Travis Atkins**, SM '88, is a program manager at the Naval Underwater Systems Center in Newport, R.I. . . . **Tommy Gardner**, SM '88, has been promoted to executive officer with the USS *Norfolk* (SSN-714) in New York City. . . . **Tony Weighous**, SM '89, is with Upjohn Co. in the Acquisitions Review Department in Kalamazoo, Mich. . . . **Cathy Iacobo**, SM '89, is a planning manager for line and page printers with IBM in Lexington, Ky. . . .

Jose Bolorinos, SM '88, is senior vice-president of customer service with Iberia in Madrid, Spain. . . . **Nam-Kuan Teo**, SM '85, is involved in a joint venture between his company, Singapore Institute of Standards & Industrial Research (SISIR), and AT&T. . . . **Kenneth W. Miller, II**, SM '83, is a proprietor of Ohio Knowledge Engineering. . . . **Taro Hattori**, SM '89, returned to Boston in September for his wife's graduation from Northeastern with an MS in human resources counseling. He is working on waterfront development in Japan with his company, Taisei Corp.

J.P. Sutton, SM '83, is deputy program director at Electronic Combat & Reconnaissance System Program Office, Aeronautical Systems Division, at Wright Patterson Air Force Base in Ohio. We were saddened to learn of the death of his wife Sharon on February 5, 1989. . . . **Moises J. Goldman**, SM '84, is now president and CEO of Appliance Wiring Components, Inc., in Joliet, Ill. . . . **Terrence C. Leslie**, SM '86, has been promoted to senior engineer at the Advanced Semiconductor Technology Center, IBM Corp., in Hopewell Junction, N.Y. . . .

Kim-Chin Tran, SM '86, is director of business development for Gamma-Metrics in San Diego, a company partially owned by Westinghouse. . . . **Remolo Ciola-Filho**, SM '87, is assistant to the vice-president of Instrumentos Cientificos C.G. LTDA in Brazil. . . . **Masafusa Atsuta**, SM '88, was in the United States for a week and stopped by to visit. His company, Hitachi Ltd., is planning a joint project with GE to build a thermal electric plant in the Tokyo area.—Mary Edwards, Management of Technology Program, Room E52-125, MIT, Cambridge, MA 02139

XVI AERONAUTICS AND ASTRONAUTICS

Joseph F. Shea, senior vice-president of engineering at Raytheon Co., has been named the 1989 Jerome C. Hunsaker Visiting Professor of Aeronautics and Astronautics at MIT. Shea directs major technology development efforts at Raytheon in the areas of Very High Speed Integrated Circuit (VHSIC) device technology; Monolithic Microwave Integrated Circuit (MMIC) device technology; computer-aided engineering radar, sonar, and composite material technology; and software development. . . . **Earle L. Messere**, SM '64, technical director of the Naval Underwater Systems Center, Department of the Navy, is one of 63 top federal employees awarded the 1989 Presidential Rank Awards at the "Distinguished Executive" level. Presented by President Bush at Constitution Hall, the award recognizes extended exceptional performance by managers in the federal government's Senior Executive Service.

Two new books by alumni: *Mechanical Toys: How Old Toys Work* by Kathleen and Athelstan Spilhaus, SM '33, (Crown Publishers, Inc., 1989)

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K.A. Rodman

is a journey through the couple's collection of more than 3,000 mechanical and antique toys. The jacket describes Athelstan as an "oceanographer, inventor, author, professor, and self-proclaimed child" who has also been director of research at NYU, president of the Franklin Institute, and fellow of the Smithsonian's Woodrow Wilson International Center for Scholars. . . . *The Starflight Handbook: A Pioneer's Guide to Interstellar Travel* by Eugene Mallove, '69, and Gregory Matloff (John Wiley & Sons, 1989), is a compendium of "the many and varied approaches to starflight now on the drawing boards of our most talented scientists and engineers," says the jacket. "Generous coverage is given to interstellar propulsion schemes of all kinds; space-time problems in starflight; long-range, star-to-Earth communications; effects of the interstellar medium on people and machines; scientific payloads; interstellar arks and colonies; and techniques for spotting extrasolar planets." Mallove is the chief science writer in the MIT News Office, and the author of *The Quickening Universe*.

James W. Clark, SM '57, died on July 29, 1989, at his home in Glastonbury, Conn. He was an assistant director of research at United Technologies Research Center, which he joined in 1956 as a research engineer trainee. During his career at the center, Clark conducted research in supersonic and hypersonic aerodynamics, aircraft stability and control, and automatic flight systems. He was involved in the corporation's Living Seas project at Walt Disney World's Epcot Center, where he helped design the pavilion's main tank and its life-support system for marine life. He also led a team of researchers who developed a gait analysis laboratory for Newington Children's Hospital. The lab helps doctors analyze walking disorders in children with cerebral palsy, neuromuscular disease, spinal cord deformities, and lower limb amputation. Clark was an avid pilot with both instrument and commercial ratings.

XVII POLITICAL SCIENCE

Kenneth A. Rodman, PhD '83, has been appointed to a tenure-track position as associate professor of government at Colby College in Waterville, Maine. He had been assistant professor of politics at New York University, where he was honored with an excellence in teaching award. The Columbia University Press has published an adaptation of Rodman's doctoral dissertation, *Sanctity vs. Sovereignty: The United States and the Nationalization of Natural Resource Industries*. . . . MIT Associate Professor of Political Science Stephen M. Meyer spoke last summer at Mitre Corp., as part of its Distinguished Lecture Series. Meyer, the director of the Soviet Security Studies Working Group at MIT's Center for International Studies, gave a talk on "Is Soviet Military Doctrine Really Changing?" In a nutshell, his answer is "yes."

XVIII MATHEMATICS

Edmund F. Kelly, PhD '70, has been promoted from senior vice-president to president of the Employee Benefits Division of the Aetna Life & Casualty Co. in Hartford, Conn. . . . Karen L.

Collins, PhD '86, is an assistant professor at Wesleyan University in the math department.

XX APPLIED BIOLOGICAL SCIENCES

From Aaron Brody, PhD '57, comes news collected at the annual gathering of alumni of the Course XX graduate program, circa 1950s and 1960s, mid-Atlantic region: Richard Brogle, PhD '60, a consultant, is married to the former Lucy Torrisi, a laboratory technologist in the Department of Food Technology prior to her marriage. She now runs a uniform-supply operation. . . . Marshall Myers, PhD '68, is director of research at McCormick & Co. . . . Myron Solberg, PhD '60, is director of the Center for Advanced Food Technology at Rutgers, the State University of New Jersey in New Brunswick, N.J. . . . John O'Neil, SM '56, and his wife, Lillian, head Food and Nutrition Press, the world's most important publisher of books and journals in food technology. . . . Alvan Pyne, PhD '63, is corporate director of Science & Technology for CPC International, one of the world's largest food processors. . . . Harmon Liebman, SM '54, is a consultant in food quality to the food industry. He is married to the former Shirley Glaser, who was a technologist in the Department of Food Technology. . . . Gerald Sapers, PhD '61, is a research scientist with the Eastern Utilization Research Laboratories of the U.S. Department of Agriculture.

The gathering was hosted by Brody and his wife and Daniel Farkas, PhD '60, and his wife. Writes Brody, "A magnificent clambake reminiscent of the many hosted by our late department head, Professor Bernie Proctor, at Ipswich's Crane Beach, was shared by the alumni and their spouses. Even if the Institute no longer has a Course XX, Department of Food Technology, its graduates continue as significant contributors in our growing profession, which is indispensable to America and the world."

XXI HUMANITIES

Kenneth R. Manning, professor of the history of science and head of the Writing Program at MIT, gave a talk on "Blacks in Medicine" to lead off a four-part series of lectures at Columbia University on "Reinterpreting the Black Experience." . . . Fred R. Shapiro, '74, has just published a book, via St. Martin's Press, entitled *LEXIS: The Complete User's Guide*. According to Shapiro, it is the first book devoted to LEXIS, which is the leading on-line database for legal research. . . . Gerald Holton, visiting professor of the history of science at MIT and a founding member of the Program in Science, Technology, and Society, has been selected by the American Institute of Physics to receive the 1989 Andrew Gemant Award in recognition of his contributions to the history and wider interpretation of physics.

XXII NUCLEAR ENGINEERING

Robert H. Wilcox, SM '58, writes that he is currently a consultant specializing in international trade, export assistance, and international project development and management (especially concerning Latin America). . . . At a White House celebration of Captive Nations Week, Tue Nguyen, PhD '89, was one of seven new Americans honored by President Bush for outstanding achievements. Nguyen, who also received four SBs at MIT (in Courses 8, 6-1, 6-3, 18, and 22) and an SM (Course 22), came to the United States as a teenage "boat person" with little English. He is now researching future semiconductor process technologies at IBM in Essex Junction, Vermont.

Deceased

The following deaths have been reported to the Alumni Association since the *Review* last went to press:

Amy R. Stearns, '15; September 8, 1989; West Orange, N.J.
George W. Ousler, '16; September 10, 1989; N. Andover, Mass.
Masaru Kametani, '25; October 11, 1989.
Emerson K. Patten, '25; January 29, 1988; Baltimore, Md.
Lester C. Hopton, '26; September 4, 1989; Boca Raton, Fla.
Dale Stetson, '27; July 29, 1989; Warren, Vt.
Henry R. Wengen, '28; September 9, 1989; Poughkeepsie, N.Y.
George A. Crandall, '29; August 10, 1989; Casper, Wyo.
William K. Bachli, '31; August 25, 1989; Randolph, Vt.
George R. Brodie, '32; August 3, 1989; Mount Dora, Fla.
George E. Connor, '32; September 11, 1989; Hingham, Mass.
Harry H. Hallas, '34; August 13, 1989; Sandwich, Mass.
Spencer H. Mieras, '36; December 14, 1987; Traverse City, Mich.
William Shockley, '36; August 12, 1989; Stanford, Calif.
Martha H. Williams, '36; July 22, 1989; Wilmington, Del.
Hergert F.W. Bunzel, '37; May 23, 1989; Orlando, Fla.
John L. Joseph, '40; September 4, 1989; Hasbrouck Heights, N.J.
Stephen A. Kaufman, '40; April 4, 1989; Clare-

mont, Calif.
John F. Gilbert, '41; September 12, 1989.
Charles E. Bossi, '42; August 24, 1989; Kettering, Ohio.
Cenan M. Sahir, '42; November 26, 1986; Istanbul, Turkey.
Philip E. Sheridan, '42; September 8, 1989; Sarasota, Fla.
Alphonse A. Corona, Jr., '44; July 4, 1989; Yardley, Penn.
Norman F. Rohn, '45; August 20, 1989; Camrillo, Calif.
Louis H. Roth, Jr., '47; May 25, 1989; Denver, Col.
Anatol W. Bigus, '49; July 24, 1989; Brookline, Mass.
William J. Raich, '49; September 19, 1989; Midland, Mich.
Frederick W. Trombley, Jr., '50; August 6, 1989; Thornton, Penn.
George A. Brown, '51; September 1, 1989.
David R. Esty, '51; August 3, 1989; Port Lucie, Fla.
Howard G. Hipkin, '51; June 12, 1989; Oakland, Calif.
John D. Robertson, Jr., '52; October 31, 1988; Taunton, Mass.
Edward B. Temle II, '52; October 16, 1975; Lexington, Mass.
Thomas J.B. Hannom, '55; January 10, 1989; Scottsdale, Ariz.
Robert B. Robinson, '58; September 8, 1988; North Myrtle Beach, S.C.
Howard S. Wagner, Jr., '68; August 21, 1989.
Bengt A. Samuelson, '71; September 12, 1988; San Mateo, Calif.
Mark R. de Lemos, '78; September 6, 1989; Berkeley, Calif.
Alan C. Eng, '80; 1985.

GAZETTE

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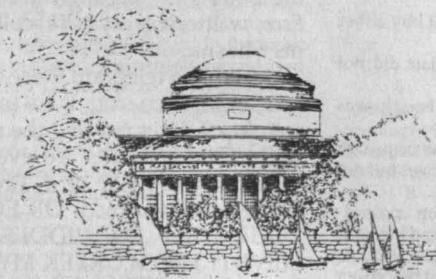
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Larger gifts can be used to establish a named endowment fund as a permanent memorial. If you would like information on ways of expressing sympathy through a memorial contribution, or on establishing a named endowment fund, please contact Betsy Millard, MIT Room E38-202, Cambridge, MA 02139 or call (617)253-8059.

Whole Lotta Shakin' Goin' On

This being the first issue of another year, we again offer a "yearly problem" in which you are to express small integers in terms of the digits of the new year (1, 9, 9, and 0) and the arithmetic operators. The problem is formally stated in the "Problems" section, and the solution to the 1989 yearly problem is in the "Solutions" section.

Problems

Y1990. Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 9, and 0 exactly once each and the operators +, -, × (multiplication), / (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 9, and 0 are preferred. Parenthesis may be used for grouping; they do not count as operators. A leading minus sign *does* count as an operator.

JAN 1. Doug Van Patter offers us a real life bridge problem from the 1988 Lancaster Regional.

You (South) are declarer in a shaky 3 NT contract. West's opening lead of seven of clubs is taken by your eight. What line of play will give you a reasonable chance for nine tricks?

NORTH

♠ K 7 6 4 3
♥ A 7 6
♦ 9 3
♣ K 10 6

SOUTH

♠ J
♥ K Q J 10
♦ A K 6 2
♣ J 8 3 2

JAN 2. Walter Cluett wants us to solve Filene's 1985 Christmas problem.

Among the shoppers one snowy Saturday morning were members of "December 25," a Christmas shoppers' club

of 12 married couples. A clerk waited on all 12 couples consecutively, as they bought a total of 8 each of the following items:

1. Gloves
2. Book
3. Perfume
4. Pearl Strands
5. Football Sweater
6. Handbag

Each husband and wife were waited on together. Each couple bought 4 items. No two couples bought the same combination of items, and none of the couples bought two or more of the same item. Using the following clues, can you determine:

1. The full name of each husband and wife
2. What order they were waited on
3. What items each couple bought

The Clues

Hint: One husband is Bob; one wife is Elizabeth and one surname is Stanton.

1. The Craigs, who bought a handbag, were waited on before the Murphys, who were not waited on last.
2. The Collins bought gloves, a sweater, a handbag, and perfume.
3. The couples waited on 8th and 10th bought a book.
4. These five couples were waited on consecutively: the Smiths, Gary and his wife, a couple who bought a book and a handbag, the Swains, and Bill and his wife.
5. Geraldine and her husband did not buy either a handbag or a sweater.
6. The couple who were waited on last did not buy pearls.
7. One of the items Tom and his wife bought was a book.
8. The Marshalls did not buy perfume or pearls.
9. Evelyn and her husband bought gloves but not perfume.
10. These five couples were waited on consecutively: Martha and her husband; Jack and his wife; the couple who bought gloves, perfume, a book, and a handbag; the couple who did not buy either pearls or a book; and Margaret and her husband.
11. The first five couples waited on all bought perfume.
12. Chuck and his wife did not buy gloves.
13. The couples waited on first, second and fourth did not buy a sweater.
14. Eleanor and her husband did not buy perfume.
15. Neither Allen and his wife, who did not buy a handbag, nor the Anthonys bought gloves.
16. Cheryl and her husband, who were not waited on 10th or 12th, and John and his wife are two couples who bought both a sweater and a handbag.
17. The Douglasses, who did not buy gloves or a sweater, were waited on 9th.
18. Adam and his wife, who did not buy a handbag, were waited on immediately before the Days.
19. Steve and his wife bought pearls, a book, a sweater and one other item.
20. The last three couples waited on did not buy

gloves.

21. The Joneses did not buy a sweater.
22. Susan and her husband bought pearls.
23. George and his wife bought a sweater.
24. The four couples who did not buy gloves are (in no particular order): Dorothy and her husband; the Craigs; Joe and his wife; and Rosalyn and her husband (who did not buy a sweater).
25. The O'Connors bought both perfume and a sweater.
26. Sandra and her husband, who did not buy a sweater, were waited on immediately before Cathleen and her husband.

JAN 3. Dave Mohr asks a discrete variant of 1988 M/J 2.

Two gamblers, you and Low Stakes, tire of dice and poker. You agree to wager on each of a number of plays of a game with the following set of rules: Each would write privately on a slip of paper three nonnegative integers whose sum must be 10. Zero is allowed (0, 2, 8 for example). Repeats are also allowed (3, 3, 4 for example). Then you compare amounts, largest against largest, smallest against smallest, and median against median. If any tie, the bet is a draw. The one with the larger amount in 2 of the 3 categories wins the wager. According to what strategy do you plan to select the numbers?

JAN 4. The following problem is from the book *The Puzzling Adventures of Dr. Ecco*, written by my NYU colleague Dennis Shasha.

"Receiving a telegram these days is most unusual," Ecco said as he tore open the envelope. After reading the message, he said, "The contents are even more so. What do you make of it, Professor?"

The telegram read: DR ECCO NEED YOUR HELP ON RIDDLE STOP BELIEVE IT FROM GREEK MYTHOLOGY STOP WILL CALL ON YOU TOMORROW AFTERNOON END.

"You are something of an amateur scholar of Greek mythology, aren't you?" I asked, pointing to a row of books.

"Quite amateur, indeed," Ecco responded modestly, "but considering the tone of this telegram, possibly more knowledgeable than our client, who may even now be pressing the doorbell."

The young man at the door looked very athletic with his polo shirt and tanned face. After introductions, he explained his problem.

"The woman I love is a graduate student in Greek literature," he said. "Her



SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

latest eccentric demand is that I solve a riddle adapted from her researches. She will marry me if I can answer three questions. Will you listen?"

"By all means," said Ecco. "Please proceed."

"There is a party," said the young man, launching into the riddle. "Everybody at the party has shaken hands with three of the other people, except for one person, who has shaken hands with only one of the other people."

"That's all the information you get, Dr. Ecco." Then he stated the three questions.

1. What is the smallest number of people who could be at such a party?
2. Could there be 21 people at such a party?
3. Is there a general pattern of how many people could be at such a party?

Speed Department

SD 1. Speedy Jim Landau wants to know how to drop an egg 4 feet without breaking it.

SD 2. Frank Model wants you to give a baseball team with all nine players major leaguers (present or past) having the last name Johnson. The three outfield positions may be combined, i.e., three outfielders are required but not all three positions need be represented (e.g., all three players could be centerfielders).

Solutions

Y1989. Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 8, and 9 exactly once each and the operators +, -, × (multiplication), / (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 8, and 9 are preferred. Parenthesis may be used for grouping; they do not count as operators. A leading minus sign *does* count as an operator.

The following solution is from John Drumheller, who extended our criteria for breaking ties. Drumheller ranks potential solutions via:

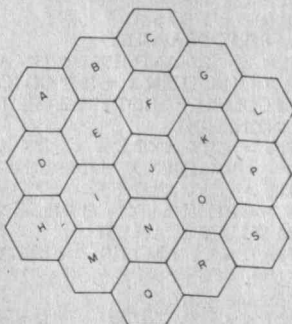
- 1) Minimum number of operators
- 2) 4 digits in order
- 3) 3 digits in order of 2 pairs in order
- 4) 2 digits in order
- 5) The simplest operators (ordered +, -, ×, /, exponential)

1	1 ⁹⁸⁹	22	198/9
2	91 - 89	23	-
3	(19 + 8)/9	24	-
4	8/((9/9) + 1)	25	9 + 8 + 9 - 1
5	-	26	(1 × 9) + 8 + 9
6	8 - ((9/9) + 1)	27	1 + 9 + 8 + 9
7	98 - 91	28	-
8	9 - 1 ⁹⁸	29	-
9	1 ⁹⁸ × 9	30	-
10	1 ⁹⁸ + 9	31	-
11	(1 + 98)/9	32	-
12	-	33	-
13	-	34	-
14	-	35	-
15	-	36	19 + 8 + 9
16	(8 + 9) - 1 ⁹	37	-
17	18 - (9/9)	38	-
18	99 - 81	39	-
19	91 - (9 × 8)	40	-
20	19 - 8 + 9	41	-
21	189/9	42	-

43	-	72	1 ⁹ × 8 × 9
44	-	73	((1/9) + 8) × 9
45	-	74	91 - 9 + 8
46	-	75	-
47	-	76	-
48	-	77	-
49	-	78	-
50	-	79	98 - 19
51	-	80	(89 × 1) - 9
52	-	81	99 - 18
53	(8 × 9) - 19	82	81 + (9/9)
54	((8 - 1) × 9) - 9	83	-
55	(8 × (9 - 1)) - 9	84	-
56	-	85	-
57	-	86	-
58	-	87	-
59	-	88	89 - 1 ⁹
60	-	89	(1 × 98) - 9
61	-	90	1 + 98 - 9
62	(9 × 8) - 9 - 1	91	819/9
63	81 - 9 + 9	92	91 + 9 - 8
64	1 - 9 + (8 × 9)	93	-
65	-	94	-
66	-	95	-
67	-	96	-
68	-	97	89 - 1 + 9
69	-	98	(1 × 9) + 89
70	89 - 19	99	891/9
71	((1 + 9) × 8) - 9	100	1 ⁸ + 99

Also solved by Allen Tracht, Bob High, Joe Feil, Daniel Mullins, Stephen Callaghan, Greg Spradlin, Steve Feldman, Charles Dale, Robbie Smith, Albert Smith, and Avi Ornstein.

A/S 1. My plea for computer-related problems has inspired Warren Himmelberger. I still need more such problems. Mr. Himmelberger wants us to devise a computer program to use the numbers 1 through 19 once each to label the hexagons below so that each diagonal sums to the same value. Note that there are six diagonals with 3 hexagons each, six with 4, and three with 5.



Matthew Fountain reports that solving this problem taught him how to use sets in Pascal. He filled the cells in a somewhat odd order and relettered the cells to correspond to that order, which was

A H B
M G N I
F O R P C
L Q S J
E K D

Fountain's solution follows:

My program running on a 20MH 386 found the following solution in less than six seconds. It took 12.4 minutes to show that it was the only solution except for mirror images and rotations.

3 19 16
17 7 2 12
18 1 5 4 10
11 6 8 13
9 14 15

It is interesting that 19 + 1 + 4 + 14 = 12 + 7 + 8 + 11 = 17 + 6 + 2 + 13 = 38, an additional symmetry involving 38.

For a complete description of how Fountain arrived at his solution and the text of his program, please write to Tech Review Puzzle, W59-212, 201 Vassar St., Cambridge, MA 02139.

Also solved by Gordon Burns, Paul Herkart, Winslow Hartford, Steven Feldman, Al Danzis, Alan Schwartz, Robert Bart, Scott Maley, Harry Zarembo, Donald Savage, Gordon Rice, and the proposer.

A/S 2. A magic square problem from Ronald Martin, who wants you to arrange the numbers from 1 to 121 in an 11 × 11 grid so that all rows, columns, and diagonals sum to 671. Note that to form most diagonals you must imagine a copy of the square placed next to the original.

The following solution is from Victor Christensen: The specific solution, an 11 × 11 magic square, is shown below:

n = 11

68	81	94	107	120	1	14	27	40	53	66
80	93	106	119	11	13	26	39	52	65	67
92	105	118	10	12	25	38	51	64	77	79
104	117	9	22	24	37	50	63	76	78	91
116	8	21	23	36	49	62	75	88	90	103
7	20	33	35	48	61	74	87	89	102	115
19	32	34	47	60	73	86	99	101	114	6
31	44	46	59	72	85	98	100	113	5	18
43	45	58	71	84	97	110	112	4	17	30
55	57	70	83	96	109	111	3	16	29	42
56	69	82	95	108	121	2	15	28	41	54

671

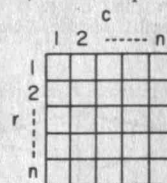
For the general case, use the following variables:
n = positive integer representing the number of cells along one edge of the square

c = current column number

r = current row number

In general, to create a magic square using each of the integers from 1 to n² (where n is odd) only once, the following method may be used:

Think of an empty square as a grid of empty cells. The position of a cell is identified using column and row coordinates (c and r, respectively), as shown below:



Place the integers in the cells using the following algorithm:

- 1) Place the integer 1 in the cell at coordinates

$$\left(c = \frac{n+1}{2}, r = 1\right);$$

this is the middle cell of the top row.

- 2) To determine the next cell to fill (call it the "target cell"), attempt to find an empty cell at coordinates (c + 1, r - 1); this cell will be upper-right diagonally adjacent to the current cell. In this attempt, one of four possibilities will result:

- a) The target cell would be beyond the upper edge of the square (r < 1); in this case, place the next successive integer in the bottom cell (row r = n) of column c = c + 1 and continue to the next target cell.
- b) The target cell is empty; in this case, place the next successive integer in the target cell and continue to the next target cell.
- c) The target cell would be beyond the right edge of the square (c > n); in this case, place the next successive integer in the far left cell (column c = 1) of row r = r - 1 and continue to the next target cell.
- d) The target cell is within legal bounds (1 ≤ c ≤ n, 1 ≤ r ≤ n), but is not empty; in this case, place the next successive integer in the cell directly below the current cell, at coordinates (c, r + 1) and continue to the next target cell.

- 3) Recurse through step 2 until all cells are filled; the magic square is now complete.

To determine what the "magic sum" (S) will be

even before a square is filled or started, divide the sum of the integers in the square (that is, the sum of the integers from 1 to n^2) by the number of columns (or rows, since they're equal) in the square.

From our math experience, we know that the sum of the integers from 1 to n is $n(n+1)/2$.

Therefore, the sum of the integers from 1 to n^2 is $n^2(n^2+1)/2$.

Dividing this quantity by the number of columns/rows, n , gives us $n(n^2+1)/2$.

Therefore, the magic sum is represented as:

$$S = \frac{n(n^2+1)}{2}$$

With the 11×11 square, we have $11(121+1)/2 = 671$,

as desired.

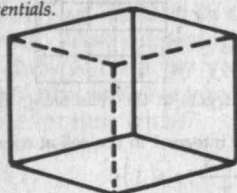
Another, more subtle, use of the above formula may be found after the square is filled (at least to the point where the center cell is filled). The center cell of a square formed using the above algorithm will always equal n^2+1 ;

in the case of the 11×11 square, we have $121+1 = 122$, which is in the center cell. Multiplying this number by n (in this case, $n = 11$) gives us the desired 671 as the magic sum. Symbolically, it results in the same formula for S as shown above.

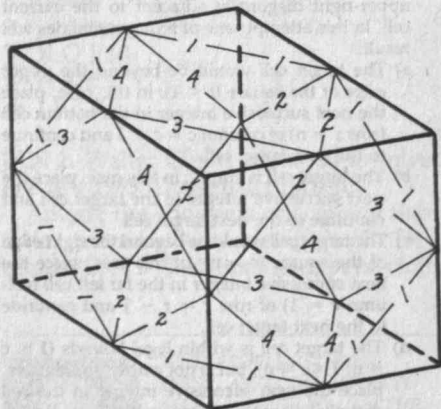
I'm sure there are more intriguing things to be discovered about magic squares, but at least now you have a basic idea of them.

Also solved by Maria Silva, Richard Bator, Don Berliner, Warren Himmelberger, Winslow Hartford, Harry Zaremba, Matthew Fountain, and the proposer.

A/S 3. Our third problem comes from a 1986 issue of IEEE Potentials.



Norman Wickstrand sent me a work of art for this one, a beautiful 4-color (plus black and white) drawing for me to enjoy and a black-and-white version that can be readily reproduced for the column.



If we connect the midpoint of each edge of the cube to the other nearest edges we will obtain the 24 light lines shown on the enclosed diagram. If we then select the lines as indicated by the numerals in the breaks in the lines we will have the required four regular hexagons. These lines are all of equal

length—by construction. Opposite lines are all parallel. Hence the hexagons are all regular. The numerals 1, 2, 3, and 4 show that there are four regular hexagons. Each of these four hexagons are in planes that divide the cube into equal parts.

Also solved by Phelps Meaker, Leonard Nissim, Avi Ornstein, Mary Lindenberg, Harry Zaremba, Matthew Fountain, Robert Bart, Winslow Hartford, Ken Rosato, and Randall Whitman.

A/S 4. Richard Hess has taken craps to an extreme and writes: In Extreme Craps, four dice are thrown and the middle two dice are ignored. Otherwise, it is played the same as ordinary craps. What is the shooter's probability of winning Extreme Craps?

I perhaps should have saved this one for a computer problem. Michael Jung's BASIC program, reprinted below, shows that the winning probability is about 53% for extended craps. For regular craps the corresponding probability is about 49%.

```

200 REM
210 REM INITIALIZATION
220 REM
230 GOSUB 2430: REM INITIALIZE SCREEN
240 GOSUB 2530: REM DIMENSION ARRAYS
1000 REM
1010 REM MAIN SEQUENCE
1020 REM
1030 GOSUB 2030: REM COMPUTE SHOT
    PROBABILITIES
1040 GOSUB 2530: REM COMPUTE WIN
    PROBABILITY
1050 END
2000 REM
2010 REM COMPUTE SHOT PROBABILITIES
2020 REM
2030 PRINT "  COMPUTING SHOT
    PROBABILITIES"
2040 FOR I1% = 1 TO 6
2050 FOR I2% = 1 TO 6
2060 FOR I3% = 1 TO 6
2070 FOR I4% = 1 TO 6
2080 REM SELECT LARGEST
2090 IF I1% >= I2% AND I1% >= I3% AND
    I1% >= I4% THEN X = I1%: GOTO 2140
2100 REM COMPUTE SHOT PROBABILITIES
    (CONTINUED)
2110 IF I2% >= I1% AND I2% >= I3% AND
    I2% >= I4% THEN X = I2%: GOTO 2140
2120 IF I3% >= I1% AND I3% >= I2% AND
    I3% >= I4% THEN X = I3% ELSE X = I4%
2130 REM SELECT SMALLEST
2140 IF I1% <= I2% AND I1% <= I3% AND
    I1% <= I4% THEN X = X + I1%: GOTO
    2180
2150 IF I2% <= I1% AND I2% <= I3% AND
    I2% <= I4% THEN X = X + I2%: GOTO
    2180
2160 IF I3% <= I1% AND I3% <= I2% AND
    I3% <= I4% THEN X = X + I3% ELSE
    X = X + I4%
2170 REM RECORD EVENT
2180 PROB(X) = PROB(X) + 1
2190 NEXT I4%
2200 REM COMPUTE SHOT PROBABILITIES
    (CONTINUED)
2210 NEXT I3%
2220 NEXT I2%
2230 NEXT I1%
2240 FOR I = 1 TO 12
2250 PROB(I) = PROB(I)/1296
2260 NEXT I
2270 RETURN
2300 REM
2310 REM DIMENSION ARRAYS
2320 REM
2330 DIM PROB(12)
2340 RETURN
2400 REM
2410 REM INITIALIZE SCREEN
2420 REM
2430 SCREEN 0,0,0
2440 KEY OFF
2450 PEN OFF
2460 CLS
2470 RETURN
  
```

```

2500 REM
2510 REM COMPUTE WIN PROBABILITY
2520 REM
2530 PRINT
2540 PRINT "  COMPUTING WIN
    PROBABILITY"
2550 REM SEVEN ON COMEOUT ROLL
2560 PWIN = PROB(7)
2570 REM ELEVEN ON COMEOUT ROLL
2580 PWIN = PWIN + PROB(11)
2590 REM 4, 5, OR 6 ON COMEOUT ROLL
2600 REM COMPUTE WIN PROBABILITY
    (CONTINUED)
2610 FOR I = 4 TO 6
2620 PWIN = PWIN + PROB(I)*PROB(I)/(PROB(I)
    + PROB(7))
2630 NEXT I
2640 REM 8, 9, OR 10 ON COMEOUT ROLL
2650 FOR I = 8 TO 10
2660 PWIN = PWIN + PROB(I)*PROB(I)/(PROB(I)
    + PROB(7))
2670 NEXT I
2680 PRINT
2690 PRINT "  WIN PROBABILITY = "; PWIN
2700 REM COMPUTE WIN PROBABILITY
    (CONTINUED)
2710 RETURN
  
```

Also solved by Winslow Hartford, Robert Bart, Matthew Fountain, Peter Silverberg, and the proposer.

A/S 5. Frank Rubin tells us about Milo Mindbender, a student at Drudgery High. After every test, Milo figures out his cumulative average, which he always rounds to the nearest whole percent. Today he had two tests. First he got 75 in French, which dropped his average by 1 point. Then he got 83 in History, which lowered his average another two points. What is his average now?

Pretty tricky! Although a few readers suggested that this problem must be a misprint, it is in fact correctly printed as the following solution from Gordon Rice illustrates:

Suppose Milo's unrounded average before the last two tests was S/N , where N is the number of tests and S is their cumulative point total. After the French test his average became $(S+75)/(N+1)$, and after the History test it is $(S+75+83)/(N+2)$.

We can assert $S/N - (S+75)/(N+1) < 2$, otherwise his rounded average must have fallen by more than 1 after the French test. We have also $(S+75)/(N+1) - (S+158)/(N+2) > 1$, otherwise his rounded average would have fallen by less than 2 after the History test. Putting them both together with a bit of algebraic manipulation, we get $N^2 + 86N + 10 < S < 2N^2 + 77N$.

For $N < 11$, the upper bound does not exceed the lower bound. For $N > 13$, S/N must exceed 100, which doesn't happen with tests. So the possibilities are:

$N = 11$ $1077 < S < 1089$
 $N = 12$ $1186 < S < 1200$
 $N = 13$ $1297 < S < 1300$

The rest is numerical experimentation. A guiding principle is that we expect the fractional part of S/N to be just less than $1/2$, so that it will round down but have as much room as possible to decrease without changing the rounded value. The solution is

$S/N = 1083/11 = 98.45$, rounding to 98 after French, $1158/12 = 96.50$, rounding to 97 after History, $1241/13 = 95.46$, rounding to 95.

Also solved by Steven Feldman, Peter Tzanetos, Winslow Hartford, Robert Bart, Matthew Fountain, Ken Rosato, Harry Zaremba, Mary Lindenberg, and the proposer.

Proposers' Solutions To Speed Problems

SD 1. Drop it 5 feet above the floor (and consider the top 4 feet).

SD 2.
 1B Deron OF Lou SS Howard
 2B Dave OF Alex C Daryl
 3B Billy OF Vance P Walter

Massachusetts Institute of Technology
Report of the President
For the Academic Year 1988-89



RANDALL WARNERS

*I believe that a sense of partnership,
of shared vision, and of shared missions
in serving the needs of society is part
of our center . . .*

A great university, like the society of which it is a part, is continually molded by the struggle of contrasting forces. It is the ancient idea of opposites in dynamic balance.

This year, I have been particularly conscious of that struggle within MIT, as we try to preserve what is best about this institution while at the same time renewing and transforming it for a new century.

I have also been conscious of the interplay of forces beyond our own walls this year — a year during which the candidates for the Presidency of the United States seemed determined to concentrate on secondary issues; when a series of Congressional hearings brought the very nature of scientific inquiry into question, and in which we witnessed the horror of students massacred in Tienanmen Square.

There were also continuing reminders this year that scientific literacy in the United States is at a low ebb. Not only do most Americans understand very little about scientific issues, they have come to distrust scientists, perhaps out of helpless anger that we have such disasters as pollution of the atmosphere, oil slicks on the seas, and hazardous wastes dumped under the earth.

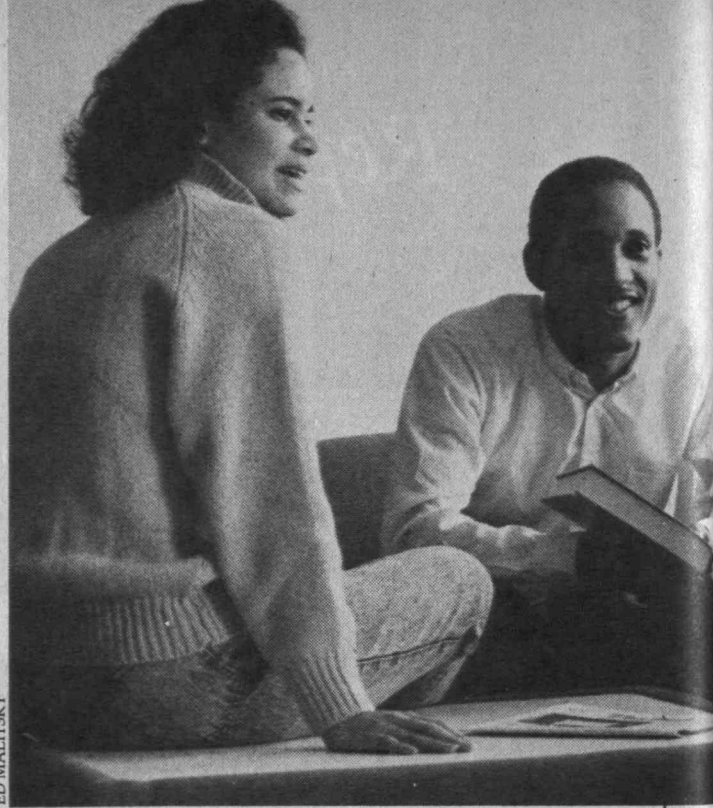
All this affects us deeply here at MIT, because a science-based university is no ivory tower. For better or worse, we are in the thick of the battle.

But this raises a problem. We welcome spirited debate; it is essential to the kind of institution and society in which we want to spend our lives. Yet for an institution, or a nation, to withstand the forces that continually pull it apart, there must be a center that holds — a sense of common cause that is broadly and deeply felt.

What is the nature of that "center" at MIT?

Certainly it includes our focus on science and technology. Certainly our refusal to equivocate about excellence is part of it. Certainly it includes our attention to the education of our students, our pursuit of research that pushes back boundaries, our respect for individual achievement, and our embracing of individual differences in background and belief that make this such a special place.

But I believe that a sense of partnership, of shared vision, and of shared mission in serving the needs of society is part of our center too. And I believe that sense needs to be strengthened and reaffirmed. In this year's report to the Corporation, I want to explore the need and the opportunities for partnership and common vision, both within MIT and among the institutions of society.



Common Cause Within MIT

The most central issues we continue to debate within MIT concern our curriculum: whom should we be educating, what should we be teaching, and how should those issues be decided. I am happy to report that we have made significant progress on all these questions this year.

First, whom should we be teaching?

Until quite recently, the majority of Americans were of European ancestry, as were most students applying to American colleges and universities. Until quite recently, the majority of students enrolling in the research universities were white and male. And until quite recently, the majority of students going to college had had adequate preparation in secondary school.

All of that is changing. America's cultural focus is no longer concentrated on Europe. The barriers of race and sex are falling, however slowly. And many of our public schools are failing.

In the 1990s, it now seems clear, both commerce and the work force will change drastically in the United States. Economic growth is likely to be slower, continuing a trend that has been evident during the 1980s. Employers will need fewer workers. However, they will need workers who are better educated and more highly skilled, because the growth occupations will be in the technical, professional, administrative, and managerial fields, and because the characteristics of jobs — essentially all jobs — will change at an accelerating pace.

Demographic data, however, show this is not the kind of labor force we are likely to have —



MIT's concern with American manufacturing and its ability to compete on an increasingly global scale permeates much of our academic enterprise.

Over the last year the Committee on Undergraduate Admissions and Financial Aid (CUAFA), working closely with the Admissions Office, conducted an intensive review of the Institute's admissions policies and procedures.

The committee compiled both quantitative and qualitative data, including in-depth interviews with faculty members and administrators, to see whether there have been discernible trends in student performance over time.

Because the quantitative data were not conclusive, the committee relied strongly on its discussions with faculty members, primarily those who have been teaching the same subjects over a long period of time.

About half the faculty interviewed expressed no major concerns about students' academic performance. The other half expressed varying degrees of concern, with the Mathematics Department expressing the most. But many faculty believe changes in students admitted to MIT reflect not so much a decline in students' academic ability as a broadening of their interests — beyond a strict focus on mathematics, science, and engineering. One math professor described his current students as "just as bright [in math], but less interested than they were ten, or even five years ago."

With respect to admissions, the committee concluded that changes in the entering class at MIT over the last thirty or so years reflect not so much changes in the pool of students available (test scores of the class entering in 1962 were very similar to those of current classes), as changes in society. They also reflect the conscious change we have made in the kind of institution MIT is: a richer and more diverse place, with a larger proportion of women and people of non-European ancestry. In recent years, test scores in mathematics and science *have* been counting less than they used to in getting into MIT because more factors are now considered.

In making its recommendations, CUAFA believes that admissions decisions should place greater weight on demonstrated capabilities in MIT's traditional strengths, science and mathematics, regardless of the student's ultimate field of study. It recommends that we continue our efforts to admit more women and minorities to the Institute; and that we continue to consider both numerical and non-numerical factors as criteria for admission.

The committee particularly believes that we must revitalize the linkages between the faculty and the admissions process at MIT, so that more

unless we recognize changing circumstances and make the appropriate changes in our educational programs. The American work force is dramatically increasing in heterogeneity, as more people emigrate to the United States from Central and South America and the Far East. Already, fewer workers speak English as their primary language. More workers than ever before are women and minorities. More are parents — especially single parents — who must juggle the demands of child care and jobs. More are, and will be, supporting aging parents as well as children. And more will be failed by our public schools.

Public schools in the United States have become so unable to do their job, in fact, that some larger companies are trying to take up the slack themselves. Not only are they providing on-the-job training, they are providing remediation in basic skills so their workers can become trained. It is bitter irony that we have seen our effectiveness in public precollege education decline to the bottom rank of developed nations even as the growing internationalization of business demands better education and stronger skills.

What will all this mean to MIT? What effect might it have on our admissions policies, particularly as they bear on undergraduate education? What effect will it ultimately have on the quality of life here?

We draw our student body from the highest ranks of the secondary schools in the United States and abroad. But for some time now, there has been a sense among some members of the faculty that the performance of MIT students in science and mathematics is declining, and that high test scores do not count as strongly as they should, and once did, as admissions criteria.



BRAD HERZOG

faculty are informed about and involved in admissions.

The report of CUAFA was made in May, very near the end of the academic year. Although there was an opportunity at the final faculty meeting of the year for a first, brief discussion of the report, we will return to the discussion in the fall so as to give faculty an opportunity to engage these issues more fully.

I believe that CUAFA, under the energetic leadership of Professor Keith Stoltzenbach, has performed a great service to the Institute in its careful review of this very important subject. I know I speak for many members of the faculty, as well as for myself, in expressing our appreciation.

The views of CUAFA concerning gender and ethnic diversity within MIT's undergraduate population also have implications for the admission of graduate students, and for recruitment and development of faculty.

MIT is indeed a meritocracy; it is part of our heritage to reward the best. But that is not mutually exclusive with another objective: to weave what Margaret Mead called "a less arbitrary social fabric." Currently, MIT's undergraduate classes are approximately one-third female and one-eighth underrepresented minorities.

At the graduate level, about 20 percent of our students are women, and about eight percent are minorities. In contrast, about 10 percent of our faculty are women, and less than two percent are underrepresented minorities. With respect to minorities, better representation on the faculty is greatly hindered by the fact that the pools of minority Ph.D.'s in engineering and science are so small — less than one percent of the cohort —

and that they have significantly decreased over the last decade, rather than increased.

Greater representation of minorities on the faculty of the Institute requires greater effectiveness in helping the ablest minority graduates to pursue doctoral-level education. In the past year, together with seven other research universities, we have undertaken a collaborative effort to develop a multi-institutional program that would provide support for underrepresented minorities through their postdoctoral years with the understanding that they would go on to pursue academic careers at one of the participating institutions. Currently, we are seeking financial support for this venture from a number of major foundations.

Obviously, such a program will take some time to bear fruit. In the meantime, it is important that we recognize the need for changes, not only in programs, but in attitudes, if we are to make real progress in achieving a pluralistic intellectual community here. I believe that one of the reasons we haven't made more progress is that so many of us at MIT have measured it in terms of our responsibility to help the underprivileged, to be compassionate, to create opportunities for those who have had less than we have. We have tended to see our equal opportunity programs as doing the right thing for someone else — as doing a favor to others by opening up our doors. No wonder we haven't made much progress. It hasn't occurred to many of us that we have something to gain, culturally and intellectually — and that is the vitality and richness that comes from incorporating and learning from differences. Instead of regarding our differences as stumbling blocks, we should see them as sources of complementary strengths — resources to be tapped for the common good.

* * *

What we should be teaching is an ongoing discussion at MIT. But since 1985, several groups of faculty have been engaged in the most thorough rethinking of the university's undergraduate curriculum in 25 years. Because it is so thorough, the full process of review and change will not be complete until sometime in the 1990s. Its objective is to ensure that our undergraduate educational programs are appropriate to the changing frontiers of science, engineering, and related fields; and that they reflect, as fully as possible, the lifelong educational needs of our graduates. The changes that result from this review will have a profound effect on the culture of the Institute.

In last year's report I discussed changes we have already made to the curriculum: to the

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General Institute Requirements with respect to the Humanities, Arts, and Social Sciences; in the advising of first-year students and in development of interdisciplinary "context courses." This year, the focus has been on grading policy, on the science core subjects, and, within the School of Engineering, on professional programs.

The School of Engineering is exploring how best to achieve a balance in its offerings between depth of competence in one professional field and breadth of exposure to other fields, both within and outside engineering. One critical question being examined is whether any engineering school can realistically prepare students to practice engineering in only four years.

In the School of Engineering and throughout the Institute, much of the current debate is an attempt to grapple with ways to expose our students to many approaches to knowledge, and to encourage them to make connections and analogies among those approaches. We are exploring whether there ought to be a fundamental rebalancing of emphasis in an MIT education, with somewhat less emphasis on principles, analysis, and research; and more on design, integration, synthesis, and implementation.

Many at MIT are convinced that the scientists and engineers of the future ought to have a broader understanding of the context in which they do their work — and beyond that, that our graduates should become better guardians of the workplace and of the environment. That means that we must open wider windows onto the world for our students. And because curriculum decisions made at MIT often become models for other institutions to follow, the decisions we are making about education here are likely to have far-reaching implications.

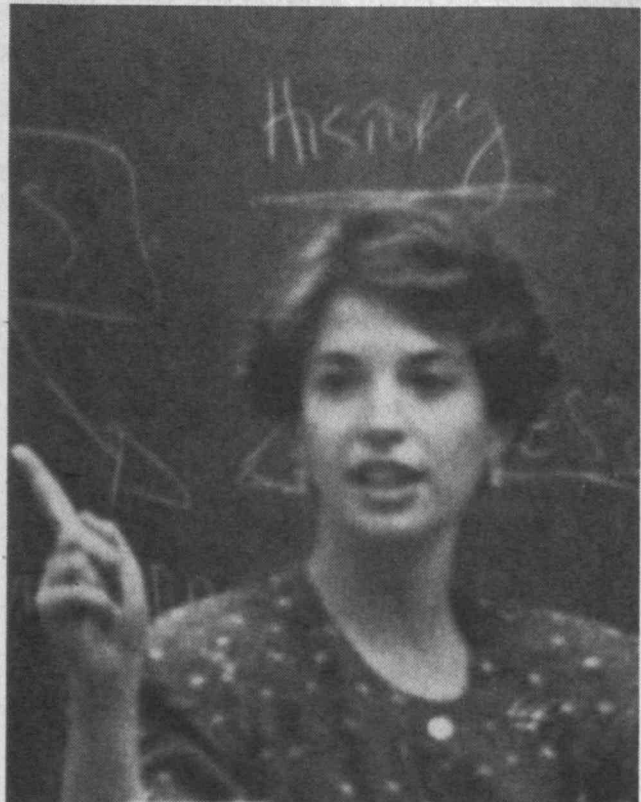
Implicit in this discussion of MIT's undergraduate curriculum is a strong concern about the scope of the education we have been providing our students for the last few decades.

In any higher civilization, there must be experts, and experts must be relied upon for advice. In our society, expert knowledge is usually deemed more necessary and worthy of reward than "liberal" or contextual knowledge. Yet all of us have had experiences which illustrate that it can be dangerous to rely completely on experts who have achieved their understanding by limiting their fields of vision. In a world that will be increasingly interconnected, our aim must be to strengthen the connections between learning a specific field, and broader, more contextual learning. It will not be an easy task.

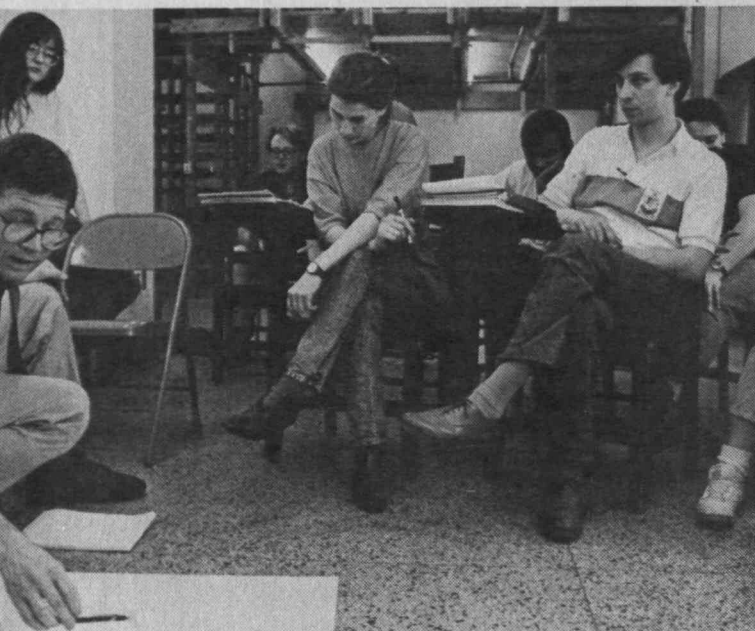
One of the most interesting—and challenging—undertakings to have emerged so far from this curriculum review has been the creation of "context courses" that are designed to explore how science and technology fit into the social order, and to encourage students to think about the intellectual, moral, and social issues associated with scientific advancements. Nine new context subjects were presented during this past year, and 13 will be offered during the 1989-90 academic year.

Those faculty who are reviewing the first two years of context activities regard them as vital to the education of our undergraduates. It is clear, however, that a structured, required context experience would not be welcomed by the faculty at this time. Nonetheless, I believe it is desirable for students to have a range of interdisciplinary perspectives and offerings in a variety of forms, so that context-type experiences are embedded into the undergraduate degree program, and I am heartened by the continuing new developments in this area.

In the review of the science component of our core requirements, the faculty voted this past May to endorse the addition of a biology requirement to the core. Currently, our students are not



L. BARRY HETHERINGTON



SUSAN LAPIDES

required to study biology (although many do), and there is a broad-based desire among the faculty for all undergraduates to have a serious intellectual acquaintance with modern biology. The form the requirement might take is not yet set. In vintage MIT style, endorsement of pilot subjects to try out several forms was explicit in the faculty's vote. A two-term integrated chemistry-materials-biology sequence, team taught by three departments, already is underway this term.

The format of a biology science core requirement will be part of the restructuring of the Science General Institute Requirements that will be voted on by the faculty in about two years' time. It is virtually certain that an addition to the science core cannot take place without coming to terms with fundamental issues concerning the current science distribution component, the physics component, and the quality of students' laboratory experience.

A review as comprehensive as the one we have undertaken cannot be accomplished without disagreement and tension, and we are experiencing both. But I believe it is a vitalizing and healthy kind of tension. People are deeply engaged in the debate, and they care very much how it all turns out.

At MIT any proposal for change that addresses the larger issues and goals of education is, and must be, done with the leadership and participation of the faculty, because it is the faculty who are responsible for determining who shall study here, what shall be studied, and how it shall be taught. Consensus-building in this process, as time consuming, nonlinear, and messy as it may be, is at the core of what the Institute is about. Certainly without broad consensus, no effective action is possible.

So as difficult as it sometimes seems to engage such fundamental issues with small, incremental steps, that is the way we must pro-

ceed if the innovations we are considering are to become part of the culture of MIT — and ultimately, to affect the course of society at large.

Common Cause Among the Institutions of Society

These are not glory days in the United States for science and technology.

The "fusion confusion" of a few months ago is an example of what can happen when scientific integrity is overtaken by the drive for fame and fortune (institutional as well as personal), and when the public and the press are so ill informed about science. In the early spring, two chemists — one from Utah, the other from England — called a press conference to announce they had achieved a form of fusion at room temperature that produced more energy than it required, raising the hope once again that the world might have a cheap, limitless energy source.

The news was reported as though nirvana were at hand. And it was reported without the necessary detailed descriptions of the work, which might have encouraged critical assessment and efforts at duplication. Even now, several months later, other scientists have been unable to duplicate that result and the public is more skeptical of science and scientists than ever.

We have experienced other troublesome indicators of public misunderstanding of the purpose and process of science and technology. Twice since last spring, representatives of MIT have testified before Congressional subcommittees on matters of concern to the scientific and academic communities. Neither occasion was cause for confidence.

On the first occasion, several senior members of our faculty appeared before a subcommittee of the House Energy and Commerce Committee, the Subcommittee on Oversight and Investigation chaired by Representative John Dingell (D-Mich.). They were there to respond to allegations that research which underlay a paper written by MIT scientists and others and published three years ago in the scientific journal *Cell* was at best in error and at worse fraudulent.

Reviews of the matter conducted at MIT; at Tufts University, where one of the coauthors serves on the faculty; and by the National Institutes of Health, which sponsored the work, all concluded that while there were some errors in the research, as happens often in science, there was certainly no fraud or misrepresentation. Nonetheless — and incredibly — this time the

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frame meaningful questions...*

Secret Service became involved, investigating researchers' notebooks.

In science, error is not a crime; it is a necessary part of the process — a process which is dispersed, interdependent, cumulative, and ultimately self-correcting. It is a process that not only fosters the rapid development of new knowledge, it enables researchers to consider new findings, make corrections for error, and verify the accuracy of results.

What was particularly disturbing about the Dingell hearings was that some members of Congress and the Congressional staff seemed unable to see any difference between intentional fraud and error. And, they suggested formal methods for reviewing research results that at best would be wasteful and unproductive, and at worst would inhibit scientific speculation and discourage research that challenges conventional wisdom or approaches.

The potential for damage to science from the attitudes represented at these hearings is very disturbing. Without better understanding of science and its methods, public support of scientific research is in question — and the specter of governmental policing of science raises its head.

The second time a member of the MIT community appeared before a Congressional subcommittee in recent months was in June, when I testified before the Subcommittee on Human Resources and Intergovernmental Operations of the House Committee on Government Operations, chaired by Representative Ted Weiss (D-NY).

I was invited by the subcommittee to prepare testimony on the subject of technology transfer, and to comment on the potential conflicts of interest that arise in collaborations between universities and corporations in the context of research. My testimony discussed the process by which new ideas move from research institutions such as MIT, where their development is usually supported by public funds, into product development and production by manufacturers, which hope to profit from them.

In my remarks I discussed the inherent tension between university research and the fruitful application of the knowledge gained from that research, describing the consideration we at MIT have given to the issues involved. I also described some of the programs we have instituted, including the Industrial Liaison Program (ILP), and the studies we have undertaken that concern US manufacturing and its productivity.

As the hearing continued, the subcommittee chose to raise other questions: whether research at

MIT in fact benefits the manufacturers of other countries, particularly Japan, more than it does American manufacturers, and whether the ILP, as a fee-for-service activity, is ethical.

Subcommittee members criticized the ILP, which has operated here for 40 years, on two grounds: first, they saw it as providing, for a few, information and access to research in progress that US corporations have already paid for through tax dollars, and, second, they were concerned that information was being made available to foreign corporations, who use it to compete against US companies.

In reality, *all* of the research done on this campus is done openly and the results are published in the open literature, sooner rather than later. A corporation need not be a member of the ILP to obtain access to research in progress (although ILP membership does ease or facilitate the process somewhat), and a great deal of industrial contact with faculty and research staff occurs outside the structure of the ILP.

The facts are that our policy on technology transfer fosters the commercialization of MIT technology, while taking into account the need to support American industry and commerce. It encourages the application and practical use of some of the fruits of federally sponsored research at MIT, and it contributes to our national competitiveness in global markets. About 95 percent of our patent licenses are issued to US companies, and whether our licenses are to US or to foreign companies, we require substantial manufacture in the United States for products sold in this country.

The subcommittee's concern about foreign (specifically Japanese) access to the fruits of US basic research is a reflection of widely shared and appropriate worries about our nation's ability to compete successfully in increasingly global markets. But in my view, improved US competitiveness will *not* be achieved by attempting to restrict the flow of information, or the movement of people associated with basic research. It will be achieved by closer attention to the processes by which new ideas emerging in research are translated into new product developments, and by which these new products are manufactured.

The subcommittee had no patience with this perspective. But in fact, MIT's concern with American manufacturing and its ability to compete on an increasingly global scale permeates much of our academic enterprise. This concern resulted in another of this year's major achievements: the publication by the MIT Press of *Made in America: Regaining the Productive Edge*.

Made in America is the report of a 16-member faculty commission from science, engineering, economics, and social science which I appointed in November of 1986. The MIT Commission on Industrial Productivity was asked to identify what has happened to US industrial performance over the last several decades and what we and others might do to improve the situation.

The commission focused on eight major industrial sectors, conducting a worldwide, "factory-floor" examination of the sources of weaknesses in productivity. Members found six recurring patterns that adversely affect productivity in US industry:

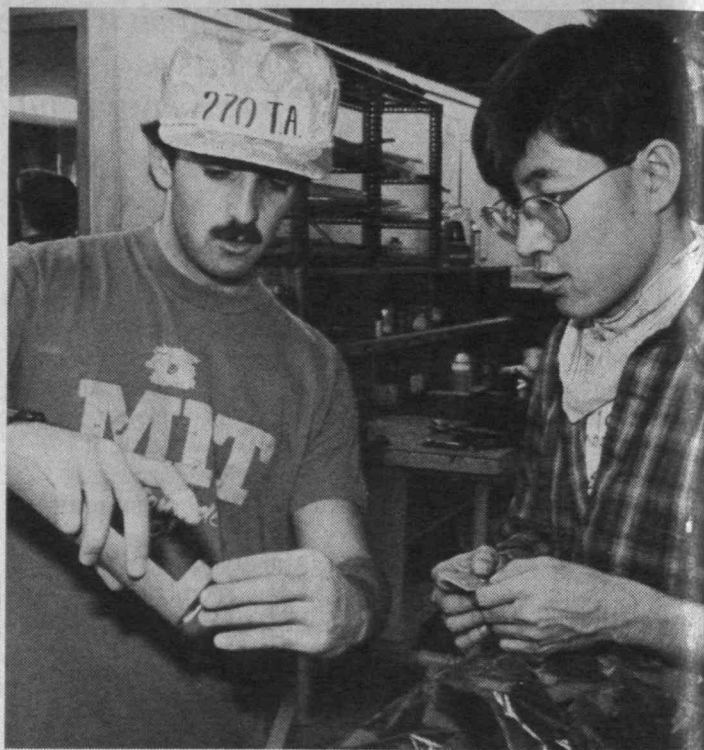
- Outdated strategies
- Short time horizons
- Technological weaknesses in development and production
- Neglect of human resources
- Failures of cooperation — within firms, between companies and suppliers, and among competitors
- Industry and government at cross purposes

The most productive firms in America, conversely, seem to have six key characteristics in common:

- Simultaneous improvement in quality, cost and delivery
- Close relations with customers
- Close relations with suppliers
- The ability to use technology for strategic advantage
- Flatter and less compartmentalized organizations
- Innovative human resource policies

One of the most important conclusions of the Commission was that if America is to remain the most productive nation on earth, we must transform the education of American managers and engineers. The report calls for greater emphasis on teamwork, and on real-world, hands-on experience in training engineers; for greater emphasis on language proficiency and international issues; and for better integration of technological, financial, and human resources.

The report also calls for establishment of a major interdisciplinary research center on productivity here at MIT, where researchers would examine productivity not only in factories and service operations, but in the office, where half of working Americans spend two-thirds of their lives.



RANDALL WARNERS

It calls on the entire MIT community to increase its awareness of the critical problems surrounding national productivity and university education. Discussion of these suggestions will occur during the coming year.

We have already taken a very significant step in this regard. A year ago, we instituted a new masters degree program called Leaders for Manufacturing, developed under the leadership of Gerald L. Wilson, Dean of Engineering, and administered jointly by the School of Engineering and the Sloan School of Management. Eleven world-class manufacturing firms are partners in the effort, which admitted its second class of students this summer.

Leaders for Manufacturing is aimed at precisely the problems the Commission on Industrial Productivity has brought into such sharp focus. Its purpose is to define an educational experience that will yield graduates who are measurably more effective in managing large manufacturing organizations than are today's managers.

The focus of the program is on industrial teamwork. Students are carrying out their projects both in the classroom and in industrial settings, and our hope is that they will emerge from the program as agents for change.

A Personal Agenda

Let me turn now to my own agenda for the coming year, which will be my last as President of MIT.

I intend to focus my attention on three broad areas: the external forces affecting education and academia, the Institute's financial health, and our human resources.

*The School of Engineering is exploring
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Most, but not all, of the external forces influencing higher education originate on the banks of the Potomac. We must be alert and ready to speak out or take action when and as it becomes necessary in a number of areas. These include:

- Continuing efforts on both the federal and state levels to balance the budget, and what those efforts may do to support of education and research
- New regulatory thrusts, on the federal, state, and local levels, in such areas as animal rights, administration of financial aid, and a drug-free workplace and work force
- The ramifications of continuing globalization of business, and of the increasing interconnection of world economies
- Demographic trends, especially as they affect the student population
- Compensation in several realms of university activity, including particularly the appointment of new faculty

Second, I plan to devote a great deal of my time and attention to the Institute's financial health — both to reducing our operating deficit through the steps I outlined to you last spring and to increasing our capital base through the *Campaign for the future*. The campaign is doing very well indeed, as I note later in this report, with gifts and pledges amounting to \$417 million as of June 30. This progress is testimony to the prodigious and unflagging efforts of scores of volunteers and of a remarkable staff, led by Vice President and Treasurer Glenn P. Strehle.

With respect to our human resources — the core of the Institute's strength — I believe we must go beyond our traditional habit of recognizing individual ability and achievement. The diversity of talents, cultures, and points of view that characterizes this community deepens the well upon which we can draw for stimulation and re-invigoration, and I believe we must learn to value it accordingly.

The process of learning, in the research laboratory as well as in the classroom and library, is an intensely personal and individual one — and therefore can be a lonely one as well. The Institute's commitment to recognizing and rewarding merit and achievement, while essential, may increase that loneliness.

I have believed for some time that we ought to give greater emphasis to the idea of a *community* of learners, and that we should be

more conscious of the ways in which all who study and work here affect the lives of others in the community. That means we need a greater awareness of the human differences that enrich this place. It means greater tolerance of, and respect for, those differences. And it means more conscious attention to the civilities that contribute so greatly to a community that is supportive of every human aspiration and hope, even as it celebrates individual achievement.

* * *

The poet of Ecclesiastes wrote, "In much wisdom is much grief, and he that increases knowledge increases sorrow." That is a sobering thought for an educator!

To *educate*, of course, means to lead out. From what, and to what, are matters for the educator to define. But it is obvious that education is not so much the explication of facts as of teaching students how to frame meaningful questions, how to proceed in seeking answers to questions never asked before, and to be wary of easy answers. I think this is particularly true at a science-based institution.

Thirty years ago, the greatest fear most Americans had was of nuclear war. Today, the prospects for peace seem much brighter, but the prospects for peace of mind do not. In place of the bomb we have a hole in the ozone layer. In place of nuclear winter, we have the threat of global warming. In place of radioactive fallout, we have pollution of our rivers and oceans with industrial waste. We have manufactured more terrifying demons than we could have imagined in the 1950s. And at least in part, and in part correctly, the public blames science and technology.

Almost ten years ago, in my inaugural address, I said I believed what was needed in this country was "not a retreat from science and technology, but a more complete science and technology." What I meant was one that takes greater cognizance of the human context in which scientific and technological developments occur.

I believe that even more strongly today. And I believe we have hardly begun to achieve the goal.

That is the role of this institution. That MIT can help to forge a more complete science and technology, and is determined to do it, is what makes this place a national treasure.

PAUL E. GRAY
September 1989

*Scientists and engineers of the future
ought to have a broader understanding of
the context in which they do their
work...we must open wider windows
onto the world for our students.*

IN SPECIAL RECOGNITION

The honors and achievements of MIT faculty and staff have been many this past year. In this part of the report I mention some of the individual efforts and awards which have given such distinction to the Institute.

Five MIT faculty members were elected to the National Academy of Engineering. Elected were: Ali S. Argon, Department of Mechanical Engineering; John D. C. Little, Sloan School of Management; Marvin L. Minsky, Department of Electrical Engineering and Computer Science; John N. Newman, Department of Ocean Engineering; and Henry I. Smith, Department of Electrical Engineering and Computer Science.

Five members of the MIT faculty were also nominated in the late spring as new Fellows of the American Academy of Arts and Sciences. Those nominated were: Richard R. Schrock, Department of Chemistry; Kenneth N. Stevens, Department of Electrical Engineering and Computer Science; Robert A. Weinberg, Department of Biology; Judith J. Thomson, Department of Linguistics and Philosophy; and Kenneth L. Hale, Department of Linguistics and Philosophy.



BRAD HERZOG

Alan H. Guth of the Department of Physics and Stephen J. Lippard of the Department of Chemistry were elected members of the National Academy of Sciences.

Two members of the MIT faculty were elected as foreign members of the USSR Academy of Sciences: Samuel C. C. Ting, Department of Physics and the Laboratory for Nuclear Engineering, and Edward N. Lorenz, Department of Earth, Atmospheric, and Planetary Sciences. The only other professor at MIT who has been elected to the USSR Academy of Sciences is Institute Professor Emeritus Victor F. Weisskopf, Department of Physics.

Institute Professor Emeritus Harold E. "Doc" Edgerton received several awards last year including being one of 15 persons to receive the National Geographic Society Centennial Award, which acknowledges men and women who have devoted their lives to expanding knowledge of the earth and its inhabitants. He also received the National Medal of Technology from President Ronald Reagan for the invention of the electronic stroboscopic flash and for finding a multitude of applications for it within science, technology, and industry.

Dr. Nevin S. Scrimshaw, Institute Professor Emeritus and director of the International Food and Nutrition Program at MIT, received the eighth annual Bristol-Myers Award for Distinguished Achievement in Nutrition Research. Professor Scrimshaw was selected for the prize for his pioneering concept of the synergism between malnutrition and infection and as the developer of the first successful low-cost vegetable weaning formula for infants.

Professor Phillip A. Sharp of the Department of Biology and Director of the Center for Cancer Research was one of the recipients of the 1988 Albert Lasker Basic Medical Research Award. His citation reads in part, "for his remarkable discoveries and brilliant analysis of the mechanism of RNA splicing The processing activities of RNA are so fundamental to life that no area of medicine or biology will be untouched by the implications of Dr. Sharp's research."

Professor Sharp also was a co-recipient of the 1988 Louisa Gross Horwitz Prize, an award he shared with Professor Thomas R. Cech of the University of Colorado at Boulder. The Horwitz selection committee cited Dr. Sharp for his discovery that DNA is assembled in some cells by a kind of "cut and paste" method from lengths of DNA that contain numerous "nonsense" segments.

Institute Professor Emeritus Victor F. Weisskopf was one of two physicists to win the 1988 Enrico Fermi Award given by the Department of Energy. The award recognizes outstanding scientific and technical achievement in the development, use, or control of atomic energy. Dr. Weisskopf was honored for his contributions to particle and nuclear physics.

Professors Vernon R. Young and Berthold K. P. Horn were both named winners of the prestigious prizes awarded by The Rank Foundation of England. Professor Young, professor of nutritional biochemistry, was cited for his work on the amino-acid metabolism of man, and Professor Horn, professor of electrical engineering and computer science, for his pioneering work which led to practical systems for computer vision.

Within the Institute, John S. Waugh, Department of Chemistry, and John D. C. Little, Sloan School of Management were appointed Institute Professors. The title of Institute Professor is an honor bestowed by the faculty on a colleague for leadership and distinguished accomplishments in the scholarly, educational, and general intellectual life of MIT and the wider academic community. Professor Waugh's principal studies have been in nuclear magnetic resonances (NMR), and his theory of coherent averaging has unified the understanding of many existing phenomena in NMR and also provided the conceptual base for the discovery of a variety of new ones.

Professor Little is widely recognized as the creator of the field of marketing science. As the ad hoc committee of the faculty reviewing Professor Little's nomination cited, "In the field of marketing science, which he virtually created and which became his main area of work, he wrote a number of original and important papers on the idea of optimal adaptive control marketing programs One of his colleagues has described his work in pulling together the behavioral and policy sciences fields in the Sloan School as 'heroic.' Another described him as a 'master teacher.'"

Professor Marvin L. Minsky, Department of Electrical Engineering and Computer Science, was selected as the 1989-90 recipient of the James R. Killian, Jr., Faculty Achievement Award. Established in 1971 as a tribute to Dr. Killian, MIT's tenth President and former Chairman of the Corporation, the award recognizes extraordinary professional accomplishment and service to the Institute. The selection committee's citation described Professor Minsky as "one of the founding fathers of artificial intelligence" and said he



PETE WISHNOK

has "exerted a marked influence on the field ever since," adding, "Sometimes a gadfly, he has produced a stream of provocative and controversial ideas which have shaped the identity and development of the field."

In the spring, John N. Tsitsiklis, Associate Professor of Electrical Engineering, was named the 1989 recipient of the Harold E. Edgerton Faculty Achievement Award. The award is given annually to a junior faculty member in recognition of exceptional distinction in teaching, research, and scholarship. The selection committee noted, "This year's recipient stands out for his excellence in cutting-edge research as well as his contributions to teaching."

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This past year several key leadership roles at the Institute changed.

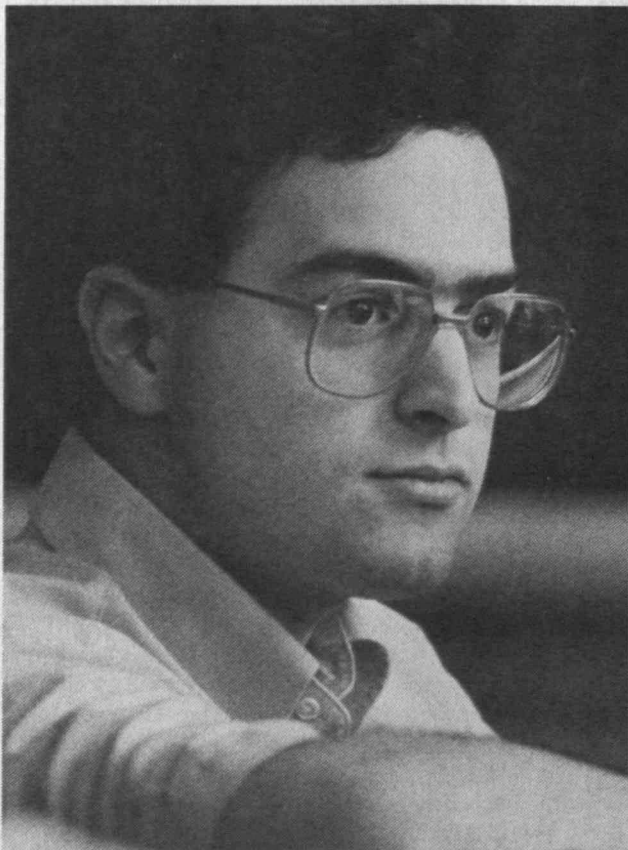
New department or program heads announced during the past year are: Jeanne S. Bamberger, Head, Music and Theater Arts Section, Department of Humanities; David J. Benney, Head, Department of Mathematics; Sallie W. Chisholm, Director, MIT-Woods Hole Oceanographic Institution Joint Program in Oceanography and Oceanographic Engineering; T. Alan Hatton, Director, Chemical Engineering Practice School; Richard O. Hynes, Head, Department of Biology; Vernon M. Ingram, Director, Experimental Study Group; Jean E. Jackson, Head, Anthropology and Archaeology

One of the most interesting. . . undertakings to have emerged so far from this curriculum review has been the creation of "context courses."

Section, Department of Humanities; Mujid S. Kazimi, Head, Department of Nuclear Engineering; Bruce Mazlish, Head, History Section, Department of Humanities; Wayne O'Neil, Head, Department of Linguistics and Philosophy; Paul L. Penfield, Jr., Head, Department of Electrical Engineering and Computer Science; Peter C. B. Phillips, Director of the Statistics Center; Jeffrey H. Shapiro, Associate Head, Electrical Engineering and Computer Science; Kenneth A. Smith, Director, Whitaker College of Health Sciences and Technology; Jefferson W. Tester, Director, Energy Laboratory.

Major changes in the Institute's central administration during the year included the appointment or promotion of the following individuals: Isaac M. Colbert, Associate Dean of the Graduate School; Joseph S. Collins, Managing Director of Alumni Activities; Ellen Harris, Associate Provost for the Arts; Eric C. Johnson, Director, Corporate Relations; Patricia Kaurouma, Director of the Office of Minority Education; and Ronald P. Suduiko, Assistant to the President for Government and Community Relations.

* * *



The Institute was saddened this year by the deaths of several longtime friends and colleagues.

Jacob P. Den Hartog died in March at the age of 87. Professor Emeritus in the Department of Mechanical Engineering, he was considered by his colleagues in the department as "the most important teacher of mechanical vibrations in the world." He made many original contributions to the solution of complex mechanical vibration problems in ships and large mechanical systems and his influence was worldwide.

Robert J. Holden, who served as associate dean of students for twenty years, died in December at the age of 71. As associate dean Mr. Holden had special responsibility for the freshman class, and he played a major role in developing counseling and orientation programs for the entering class. He retired from MIT in 1982.

Richard C. Lord, professor emeritus of chemistry at MIT and director emeritus of its Spectroscopy Laboratory, died in April at the age of 78. Dr. Lord was known for his research applying spectroscopy to the solution of chemical and biological problems. He also made widely recognized contributions to the interpretation of the infrared spectra of molecules in terms of their vibrational motion, and also to the understanding of the cohesion of molecules by means of hydrogen bonds.

Richard Stetson Morse died in July 1988 at the age of 76. An MIT graduate, he founded the National Research Corporation and served as its chief executive officer for 20 years and then as Assistant Secretary of the Army under Presidents Dwight D. Eisenhower and John F. Kennedy. He then returned to the Institute to teach a course in new enterprises at the Sloan School of Management. Dr. Morse retired from MIT in 1977.

Manfred Rauscher, an MIT graduate who stayed at the Institute to become one of the early teachers of aeronautical engineering for more than 20 years, died January 1988 in Switzerland at the age of 83. Dr. Rauscher, a leading authority on aircraft wing flutter and a renowned mathematician, taught at MIT until 1950 when he returned to his native Switzerland and a professorship in aeronautics at the Polytechnicum in Zurich.

Robert B. Semple, a Life Member Emeritus of the MIT Corporation, died in November at the age of 78. A 1932 graduate of MIT, Mr. Semple was named president of the Wyandotte Chemicals Corporation in 1949 and later was chairman of the BASF Wyandotte Corporation. He was elected to the Corporation in 1961 and to Life Membership in 1967, becoming emeritus in 1985.

STATISTICS FOR THE YEAR

The following paragraphs report briefly on various aspects of the Institute's activities and operations during 1988-89.

Registration

In 1988-89 student enrollment was 9,500, compared with 9,565 in 1987-88. This total comprises 4,325 undergraduates (compared with 4,377 the previous year) and 5,175 graduate students (compared with 5,188 the previous year). The international student population was 1,964, representing 8 percent of the undergraduate and 31 percent of the graduate population. These students were citizens of 96 countries. Students with permanent resident status are included with US citizens.

In 1988-89, there were 2,429 women students (1,412 undergraduate and 1,017 graduate) at the Institute, compared with 2,389 (1,384 undergraduate and 1,005 graduate) in 1987-88. In September 1988, 338 first-year women entered MIT, representing 34 percent of the freshman class.

In 1988-89, there were 1,637 minority students (1,331 undergraduate and 306 graduate) at the Institute, compared with 1,475 (1,236 undergraduate and 239 graduate) in 1987-88. Minority students included 332 Black Americans (non-Hispanic), 30 Native Americans, 353 Hispanic Americans, and 922 Asian Americans. The first-year class entering in September 1988 included 374 minority students, representing 38 percent of the class.

Degrees Awarded

Degrees awarded by the Institute in 1988-89 included 1,193 bachelor's degrees, 1,068 master's degrees, 41 engineer's degrees, and 492 doctoral degrees — a total of 2,794 (compared with 2,771 in 1987-88).

Student Financial Aid

During the academic year 1988-89, the undergraduate student financial aid program was again characterized by an increase in the overall need for financial aid and in the aggregate amount of grants made available. There was an increase in the amount of MIT loans awarded, but Guaranteed Student Loans obtained from commercial sources decreased.

A total of 2,390 undergraduates who demon-

strated the need for assistance (55 percent of the enrollment) received \$20,493,000 in grant aid and \$4,545,000 in loans. The total, \$25,038,000, represents a 19 percent increase in aid compared with last year.

Grant assistance to undergraduates was provided by \$6,410,000 in income from the scholarship endowment, by \$2,056,000 in outside gifts and federal allocations to MIT for scholarships, and by \$3,478,000 in direct grants from outside sources, including ROTC, to needy students. In addition, \$8,549,000 in scholarships from MIT's unrestricted funds was provided to undergraduates, inclusive of the special program of scholarship aid to minority group students, which represented \$139,000, and the MIT Opportunity Awards, which accounted for \$256,000. An additional 626 students received grants from outside agencies, irrespective of need. The undergraduate scholarship endowment was increased by the addition of \$3,183,000 in new funds, raising the principal of the endowment by 6 percent, to \$53,998,000.

Loans totaling \$4,545,000 were made to needy undergraduates — a 40 percent increase from last year. Of this amount, \$912,000 came from the Technology Loan Fund and \$3,633,000 from the Perkins (formerly National Direct Student) Loan Fund. Not included in the foregoing summary is an additional \$3,495,000 obtained by undergraduates from state-administered Guaranteed Loan Programs and other outside sources.

Graduate students obtained \$2,066,000 from the Technology Loan Fund. In addition, \$691,000 was loaned by MIT under the Guaranteed Student Loan Program. The total, \$2,757,000, represents a 45 percent increase over last year's level. Graduate students obtained \$3,721,000 from outside sources under the Guaranteed Student Loan Program — 7 percent more than last year. The total loaned by MIT to both graduate and undergraduate students was \$7,302,000, a 43 percent increase over last year.

[NOTE: All of the numbers reported in this section reflect awards from the academic year perspective, and so will not agree exactly with fiscal-year-based records reported by the Comptroller or the Treasurer.]

Career Services and Preprofessional Advising

This was a year when the demand for scientists and engineers could be described as broad rather than intense. Few industries were particu-

It is important that we recognize the need for changes, not only in programs, but in attitudes, if we are to make real progress in achieving a pluralistic intellectual community...

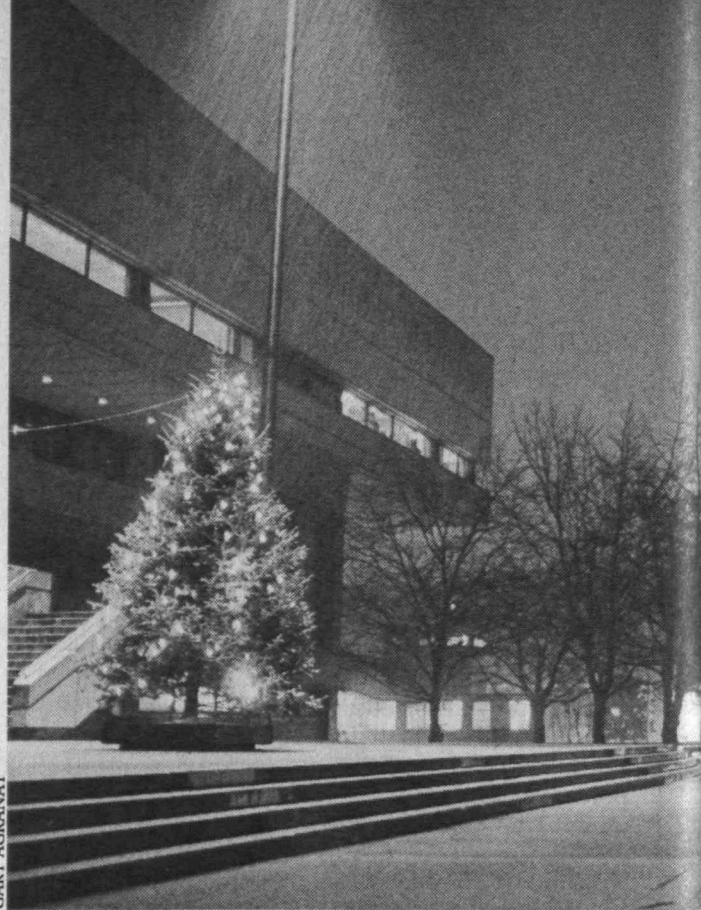
larly hungry for talent — not surprising after six years of uninterrupted economic growth — but the number of employers with openings to fill made up for the lack of intensity. A total of 432 employers made recruiting visits, a near record. They included 413 companies and 19 government agencies. As in 1987–88, more than one in ten were financial houses and consulting firms interested in students with strong general skills rather than with specific training.

The number of students having interviews was the highest ever, approximately 1,830, compared with 1,635 the year before. The interview count is estimated at a little under 10,000.

The lack of intensity in the market was reflected in salary offers. In many disciplines starting salaries barely kept up with inflation. Thus, offers to bachelors rose 4.4 percent in mechanical engineering, 3.2 percent in electrical engineering, and 3.1 percent in computer science. The highest percentage gains at the bachelor's level were in aeronautical and astronautical engineering (up 6.4 percent), chemical engineering (up 7.0 percent) materials science and engineering (up 7.8 percent) and management (up 6.4 percent). It is not clear that any of these high percentages reflect a surge in demand. Special circumstances can be cited in each case. Offers to bachelors in aeronautical and astronautical engineering did not rise at all in 1987–88; there has been a shortfall of students in chemical engineering since the collapse in oil prices in 1982; and students in management have benefited from the high salaries offered by Wall Street houses and leading management consulting firms.

In most disciplines, offers at the master's level rose less than those at the bachelor's level, and offers to Ph.D.'s rose even less. Thus, in electrical engineering, offers to master's candidates rose only 2.6 percent, and offers to Ph.D.'s rose a bare 1 percent. In aeronautical and astronautical engineering, offers to masters actually declined. The exception to this tale of offers declining with degree level is management. The Career Development Office at the Sloan School reports that the median offer to Sloan masters jumped 10 percent.

Contrary to the national trend, the number of MIT applicants to medical school rose significantly, to 131, compared with 111 in 1987–88. A jump in the number of alumni applicants was responsible for all of the increase. The 83 undergraduates who applied, and the 5 graduate students, represented a decrease from the year before. The 43 alumni applicants were up from 16 in 1987–88. To date, 87 percent of the undergradu-



GARY AGRANAT

ates have been accepted, 80 percent of the graduate students, and 74 percent of the alumni. Almost certainly more candidates will be accepted before schools open in the fall.

Finances

As reported by the Vice President for Financial Operations and the Treasurer, the total financial operations of the Institute, including sponsored research, amounted to \$947,175,000, a decrease of 0.4 percent over 1987–88. The decrease in expenses results primarily from a reduction in subcontracts at the Lincoln Laboratory and the adoption by the Institute of depreciation accounting for buildings and equipment. Net of these changes, the programs of the Institute grew by 4.8 percent in total operating expenses. Education and general expenses — excluding the direct expenses of departmental and interdepartmental research and the Lincoln Laboratory — amounted to \$405,272,000 during 1988–89, compared with \$388,885,000 in 1987–88. The direct expenses of departmental and interdepartmental sponsored research on campus increased from \$194,418,000 to \$198,849,000, and direct expenses of the Lincoln Laboratory's sponsored research decreased from \$367,155,000 to \$343,054,000.

Current revenues used to meet the Institute's operating expenses totaled \$935,870,000, augmented by \$5,882,000 in current gifts and \$5,423,000 of other fund balances.

The major renovation work in the Julius A. Stratton Building (housing the Student Center) and



the Plasma Fusion Center were substantially completed during the year. Work was begun to convert an existing building at 143 Albany Street to a graduate dormitory. New construction work for the expansion of the Rotch Library and the Bates Linear Accelerator was also begun. Stated on a comparable basis using depreciation accounting which was adopted in fiscal 1989, the book value of educational plant and equipment increased from \$248,246,000 to \$297,958,000.

At the end of the fiscal year, the Institute's investments, excluding retirement funds, student notes receivable, and amounts due from educational plant, had a book value of \$1,141,332,000 and a market value of \$1,523,353,000. This compares with book and market values of \$1,064,202,000 and \$1,396,607,000 last year.

Gifts

Gifts, grants, and bequests to MIT from private donors in 1988-89 were \$78,408,000. This is the Institute's second highest total and compares with \$83,710,000, the highest amount, received in 1987-88. The Alumni Fund reported gifts of \$14,407,000, a new high and 16 percent above the previous year.

The Institute announced the *Campaign for the future* on October 22, 1987, with \$210 million of gifts and pledges already committed. The campaign total was \$417 million on June 30, 1989. Much of this increase has been in pledges, which will add to the gift totals in the next several years as received. The major objectives of the campaign

Greater representation of minorities on the faculty of the Institute requires greater effectiveness in helping the ablest minority graduates to pursue doctoral-level education.

are support for faculty, student financial aid, academic initiatives throughout the Institute, new and renovated facilities, and unrestricted funds. Campaign events continue to be held both on and off campus to inform donors of the Institute's varied programs. The success of the campaign is attributable to the participation of the volunteers, faculty, and staff.

Physical Plant and Campus Environment

Major design and construction activities this year included completion of the renovation of the lower floors of Julius A. Stratton Center; commencement of construction on the conversion of an existing mill building complex located at 143 Albany Street into a 190-bed graduate student residence; the long-awaited beginning of construction of an addition to the Rotch Architectural Library; completion of the Northeast Sector Master Plan covering an area of the main campus bounded by Main Street, Ames Street, Buildings 16/56/66, Buildings 26/36, and Vassar Street; and retention of an architect to begin design of a new biology building that will be located on a portion of the former TRW/Carr Fastener site at the corner of Main and Ames Streets. In addition, alterations to the east wing of the Nabisco Building for the Alcator C-Mod research cell and associated support facilities were completed as were renovation of the former bar and Riverside Lounge at the Faculty Club.

This year the Institute continued its commitment to energy conservation, with its attendant cost avoidance, by implementing a shared savings electricity conservation program in conjunction with Cambridge Electric Light Company. During the year, five energy service companies (ESCO) retained by MIT installed conservation equipment and systems with a value in excess of \$4.3 million at no front-end cost to the Institute. Savings of some \$700,000 annually are currently being realized after shared savings payments of \$1.2 million have been made to the ESCO firms. The shared savings payments will continue for four to five years, after which time all savings will accrue to the Institute. Because of rapidly escalating water and sewer rates, water costs are beginning to challenge fuel and electricity in the Institute's overall utility budget. As a result of these economic pressures, the Institute is moving to reduce its water use by at least one-fourth with a broad conservation program patterned on the successful energy conservation programs of the last two decades.

MIT LIFE INCOME FUNDS



MR. AND MRS. H. "MAC" McCURDY

HOME: Seattle, Washington

CAREER: Coming to MIT after serving in the Navy during World War I, Mr. McCurdy, ME '22, was dismayed to discover that MIT had neither a boathouse nor rowing shells. Nonetheless, he put together MIT's rowing team, which in 1922 achieved varsity status. In the ensuing years, he funded a series of MIT shells, the McCurdy Lounge in the Pierce Boathouse, the H.W. McCurdy Endowment for Crew and, in 1988, the nation's first coaching chair for crew. A member of the National Rowing Hall of Fame, he has been officially designated the "Father of MIT Crew."

On the day he graduated from MIT, with \$60 of his own and \$50 borrowed from his roommate, Mr. McCurdy married Catharine McManus, an alumna of the New England Conservatory of Music. Starting as a laborer and time keeper for the Puget Sound Bridge and Dredging Company, he advanced to chairman of the board. In 1959 he sold the company and is now chairman of a family-owned business, the Puget Sound Dredging Company.

GIFT OF CAPITAL: Life income Annuity Trusts, the principal designated for endowment for crew, including the H.W. McCurdy Crew Coach Fund.

QUOTE: "Through MIT life income funds, I can support an activity that has had my lifelong dedication. Crew is an ideal college sport, providing a form of competition that fulfills the highest ideals of amateur athletics. No one will ever make a dollar pulling an oar."

For more information about gifts of capital, call D. Hugh Dardeñ or Frank H. McGrory at MIT at (617) 253-3827.

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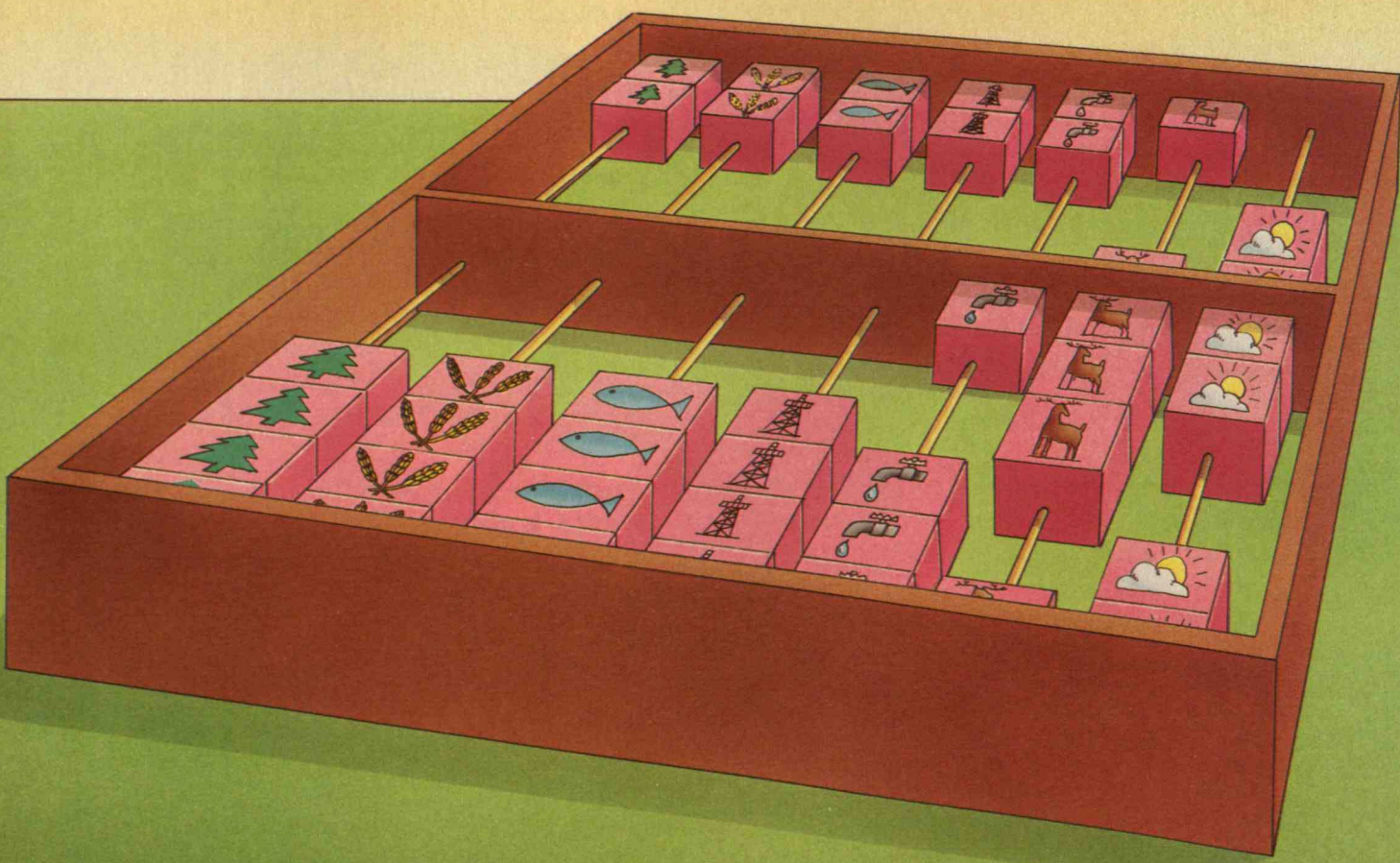
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*By ignoring natural resources,
statistics such as GNP can record illusory gains in income
and mask permanent losses in wealth.*



Wasting Assets

THE NEED FOR NATIONAL RESOURCE ACCOUNTING

NATIONAL income accounts, which provide the framework for analyzing the performance of an economy, are one of the most significant social inventions of the twentieth century. Their political and economic impact can scarcely be overestimated. Consider the most famous component of these statistics, gross national product (GNP). When quarterly GNP figures emerge, policymakers stir. Should the numbers be lower, even marginally, than those of the preceding three months, a recession is declared, the strategies and competence of the administration are impugned, and public debate ensues.

The current system, first published in 1942, reflects the Keynesian model that dominated macroeconomic thought at the time. It carefully defines and measures the great aggregate concepts of Keynesian analysis—consumption, savings, investment, and government expenditures. But Keynes and his contemporaries were preoccupied with the Great Depression and the business cycle—they wanted to explain why an economy could remain at less than full employment for such a long time. The least of their worries was a scarcity of natural resources.

Just as Keynesian analysis largely ignores the productive role of these resources, so does the United Nations system of na-

BY ROBERT REPETTO

ILLUSTRATION: MICHAEL MC GURL



*There is a dangerous
asymmetry in the way we think
about natural resources versus
other assets.*

tional accounts, which most countries follow closely. As a result, a nation could exhaust its mineral reserves, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife to extinction—all without affecting measured income.

The difference in the treatment of natural resources and other tangible assets provides false signals to both economists and politicians. It reinforces a false dichotomy between the economy and the environment that leads them to ignore or destroy the latter in the name of development. It confuses the depletion of valuable assets with the generation of income. And it promotes and validates the idea that rapid economic growth can be achieved and sustained by exploiting the resource base.

The consequences can be illusory gains in income and permanent losses in wealth. The situation is especially serious for low-income countries, which are typically heavily dependent on natural resources for employment, revenues, and foreign exchange. As long as these governments use a system for national accounting and macroeconomic analysis that almost completely ignores their principal assets, their future is in jeopardy.

No Free Gifts

National income accounts have become so much a part of our life that it is hard to remember they are scarcely 50 years old. It is no coincidence that this half-century has been one in which the governments of most countries have taken responsibility for the growth and stability of their economies.

Before the mid-1800s, classical economists regarded income as the return on three kinds of assets: natural resources, human resources, and invested capital—land, labor, and capital, in their vocabulary. However, natural-resource scarcity played little part in neoclassical economics, from which most contemporary economic theories derive. In nineteenth-century Europe, steamships and railroads were markedly lowering transportation costs, while grains and raw materials were flooding in from North and South America, Australia,

lia, Russia, and the imperial colonies. What mattered to England and other industrializing nations was the pace of investment and technological change. Thus, neoclassical models concentrated almost exclusively on labor and invested capital.

The result is a dangerous asymmetry in the way we think about and measure the value of natural resources versus other assets. Buildings and equipment, for example, count as productive capital, and their depreciation is subtracted from the value of production. Consumption that diminishes the stock of capital is seen to reduce the sustainable level of income. But natural-resource assets are not so valued, so their loss entails no debit that would suggest a decrease in future production.

Should a farmer cut and sell timber to pay for a new barn, the farm's private accounts would reflect the acquisition of one asset—the barn—and the loss of another—the timber. The farmer is better off only if the barn is worth more to him or her than the timber. In national accounts, on the other hand, income and investment would rise as the barn was built *and* as the wood was cut. Nothing would reflect the loss of a valuable asset.

Such anomalies come from the implicit, and inappropriate, assumption that natural resources are so abundant that a small loss has no economic cost. But natural resources make important contributions to economic productivity and face increasing pressure from human activities. Strictly speaking, they are economic assets.

Natural resources are also assumed to be “free gifts of nature,” entailing no investment costs to be written off. However, the real value of an asset is its income potential, not its investment cost. For example, brilliant ideas are the principal assets of companies worth billions of dollars. The Polaroid camera, the Apple computer, and the Lotus spreadsheet are worth vastly more than what their inventors spent to develop them.

It is important to remember that the common formulas for depreciating investment costs are just convenient rules of thumb and, in many cases, artifacts of tax legislation. The true measure of depreciation is the amount that future income will decline as an asset decays or becomes obsolete. Just as machines depreciate as they age, soils depreciate when their fertility diminishes.

The fundamental definition of income does, in fact, encompass the notion of sustainability. Accounting and economics textbooks alike say that income is the

ROBERT REPETTO is director of the Economic Research Program of the World Resources Institute in Washington, D.C. He is the author of several books, including *The Global Possible* (Yale University Press, 1985) and *Public Policies and the Misuse of Forest Resources* (Cambridge University Press, 1988). He wishes to thank John Ceccatti for his help in editing this article, and William Magrath, Michael Wells, Christine Beer, and Fabrizio Rossini for their contributions to the underlying research.

Indonesia's gross and "net" domestic product...

In 1973 rupiah
(billions)

CHANGE IN NATURAL RESOURCES

Year	GDP	Petroleum	Forestry	Soil	Net adjustment	NDP
1971	5,545	1,527	-312	-89	1,126	6,671
1972	6,067	337	-354	-83	-100	5,967
1973	6,753	407	-591	-95	-279	6,474
1974	7,296	3,228	-533	-90	2,605	9,901
1975	7,631	-787	-249	-85	-1,121	6,510
1976	8,156	-187	-423	-74	-684	7,472
1977	8,882	-1,225	-405	-81	-1,711	7,171
1978	9,567	-1,117	-401	-89	-1,607	7,960
1979	10,165	-1,200	-946	-73	-2,219	7,946
1980	11,169	-1,633	-965	-65	-2,663	8,506
1981	12,055	-1,552	-595	-68	-2,215	9,840
1982	12,325	-1,158	-551	-55	-1,764	10,561
1983	12,842	-1,825	-974	-71	-2,870	9,972
1984	13,520	-1,765	-493	-76	-2,334	11,186

Average
annual
growth

7.1%

4.0%

...and investment

GDI	Resource depletion	NDI
876	1,126	2,002
1,139	-100	1,039
1,208	-279	929
1,224	2,605	3,829
1,552	-1,121	431
1,690	-684	1,006
1,785	-1,711	74
1,965	-1,607	358
2,128	-2,219	-91
2,331	-2,663	-332
2,704	-2,215	489
2,783	-1,764	1,019
3,776	-2,870	906
3,551	-2,334	1,217

amount someone can consume now without reducing future consumption. Business income is the dividend a firm can pay without reducing net worth. Depreciation recognizes that unless physical assets are maintained, future consumption will decline. The failure to extend this concept to natural-resource assets is a major inconsistency.

Keeping Score Correctly

For resource-based economies, this failure seriously distorts evaluations of economic performance. Indonesian data illustrate the shortcomings of traditional accounts.

Over the past 20 years, Indonesia has drawn heavily on its considerable natural-resource endowment to finance development. Revenues from oil, gas, hard minerals, and timber and other forest products have offset a large share of government expenditures. The country's recent economic performance is generally judged to have been successful. Only a handful of countries have exceeded its growth in per capita gross domestic product (GDP), which averaged 4.6 percent per year from 1965 to 1986.

But a closer look reveals how much this evaluation is affected if the score is kept more correctly. Compare the growth of Indonesia's GDP with that of its "net" domestic product, which we have derived by subtracting estimated depreciation for soil erosion on Java and for petroleum and timber (see table). While GDP increased 7.1 percent per year from 1971 to 1984, the net

Indonesia's remarkable economic growth is less impressive when national income accounts are adjusted for soil erosion, shrinking forests, and declining oil reserves.

figure rose only 4.0 percent. If we exclude 1971, an exceptional year because of significant additions to petroleum reserves, the growth rates to 1984 are 6.9 percent for gross and 5.4 percent for net domestic product. Either way, the conventional

measure substantially overstates income and growth.

The overstatement may actually be far greater, since we have not yet looked at many important exhaustible resources, such as coal, copper, tin, nickel, and natural gas. Nor have we calculated the depreciation of renewable resources, such as fisheries and non-timber forest products.

Other important macroeconomic measures are similarly distorted. According to the World Bank, Indonesia's gross domestic investment was a healthy 26 percent of GDP in 1986. This statistic is central to planning, especially in countries that must sell natural resources to diversify their economic base and sustain long-term growth. It is relevant, therefore, to adjust gross domestic investment based on the value of natural-resource depletion. In fact, the adjustment we have calculated in Indonesia is large for many recent years, particularly in 1979 and 1980, when the losses actually exceed investment (see table).

Other problems arise in evaluating specific economic sectors, such as agriculture. Almost three-fourths of Indonesians live on the fertile "inner" islands of Java, Bali, and Madura, where population pressures have led farmers to grow maize, cassava, and other crops. As hill-sides have been cultivated, erosion has increased to an estimated average of 60 tons per hectare per year.



*A proper accounting of
natural-resource depletion would flash an
unmistakable warning to countries on
an unsustainable course.*

Erosion's economic consequences include lost nutrients and soil fertility and increased downstream sedimentation in reservoirs, harbors, and irrigation systems. By ignoring these costs, income accounts significantly overstate the growth of agricultural income in Indonesia's highlands. Although upland crop yields have improved as farmers have used better seed and more fertilizers, the farm income that will be lost owing to the annual depreciation of soil fertility is about 4 percent of the value of crop production—equal to the annual production increase. In other words, in Indonesia's uplands, farm output is increasing at the expense of future output.

Such an accounting of natural-resource depletion should flash an unmistakable warning that a country is on an unsustainable course. A system that does not highlight dangers like these is a deficient tool for analyzing resource-based economies.

Of course, nations legitimately draw on natural resources to fund economic growth. This is especially true in resource-dependent countries, where the revenues pay for education, increasing industrial capacity, and developing infrastructure. To help planners invest resources wisely, a reasonable accounting system would identify when one kind of asset is exchanged for another.

Revising the Accounts

Fortunately, a large and growing body of experts has recognized the need to reform the national accounting systems. For example, in 1985, the Organization for Economic Cooperation and Development (OECD) issued its report, *Declaration on Environment: Resources for the Future*, which endorses steps to ensure "long-term environmental and economic sustainability" and commits OECD nations to developing "more accurate resource accounts." Similarly, *Our Common Future*, the 1987 study by the U.N.-sponsored World Commission on Environment and Development, observes that "in all countries, rich or poor, economic development must take full account in its measurement of growth of the improvement or deterioration in the stock of natural resources."

Some developed countries have already established environmental accounting systems. In both Norway and France, extensive resource accounts supplement the national economic accounts. The West German government recently announced that it will include resource and environmental degradation in its national income

accounts. These systems reflect two types of approach to natural-resource accounting.

On the one hand, planners can register the stocks of natural resources—and changes in those stocks—in physical units. Opening stocks *plus* all additions *less* all reductions *equals* closing stocks. Consider, for example, timber resources. Additions to the timber stock can originate from growth and regeneration of the initial supply, from reforestation, and from planting new forest. Production (harvesting), natural degradation (for instance, fire), and deforestation by humans would reduce the stock. Separate accounts might be established for categories such as virgin production forests, logged (secondary) forests, protected forests, and plantations. In temperate forests, which have relatively few tree types, stocks could be further classified by species. In each case, cubic meters of available wood is probably the most important measure, since a substantial part of a nation's standing timber cannot be profitably harvested with current technology or sold under today's market conditions.

However, physical accounting by itself has considerable shortcomings. First of all, it does not lend itself to amassing many different accounts into a single useful number. Combining the cubic meters of various tree types obscures wide variations in the economic value of different species. Similarly, aggregating total mineral reserves in tons obscures the vast differences that grade and recovery costs make in the value of deposits. But maintaining physical accounts in fine detail yields a mountain of hard-to-manage statistics.

Further, physical accounts must be expressed in monetary terms before planners can directly integrate them into economic decisions—presumably the point of the exercise. (The necessary calculations rely on the concept of economic rent, which is broadly equivalent to the net price. For example, if a barrel of crude oil can be sold for \$10 and costs a total of \$6 to discover, extract, and market, each barrel has a rent of \$4. Natural-resource rents arise from factors such as the scarcity and location of particular stocks.)

Like physical accounts, monetary valuation has its limits, set mainly by how tightly a resource is tied to the market economy. Some resources, such as many minerals, are relatively easy to value in monetary terms, but others, such as noncommercial wild species, can be valued only through quite roundabout methods involving numerous, somewhat questionable assumptions.

Thus, Norway's resource accounts are tabulated in

Environmental Accounting in Developed Countries

physical units, such as tons or cubic feet, and are not directly integrated with the national income accounts. Norway compiles accounts for "material" resources such as fossil fuels and other minerals, "biotic" resources such as forests and fisheries, and "environmental" resources such as land, water, and air. However, the Central Bureau of Statistics does express some important resource accounts, especially those for petroleum and gas, in monetary terms for macroeconomic planning and projection models.

France's "natural patrimony accounts" have been designed to provide a comprehensive framework for monitoring changes in all resources that can be affected by human activity. Since 1971, French statisticians have been developing the methodology for these accounts and compiling empirical estimates of the stocks of specific resources. The patrimony accounts now cover the same range of resources as Norway's: non-renewables, the physical environment, and living organisms. As in Norway, the basic accounting units are physical, with monetary values for resources that are sold or contribute directly to producing marketable goods.

Some developing countries, recognizing their dependence on natural resources, have also become interested in a better accounting framework. The World Resources Institute is working on pilot studies with government researchers and statistical agencies in Indonesia, Costa Rica, and the People's Republic of China. The Philippines' government has recently begun compiling resource accounts, and the World Bank and the U.N. Environment Programme are planning to carry out limited experimental studies in Thailand, the Ivory Coast, Argentina, and possibly some other countries.

The Role of the United Nations

Since most developing countries must think of natural resources as productive assets, the first priority is to document these reserves in a way that gives due emphasis to the costs as they disappear. Here, the U.N. Statistical Office has an important role to play. Its system of national accounts (SNA), which includes privately owned assets used in the commercial production of goods and services, supplies a standard that most countries follow closely, at least in its main accounts. The Statistical Office is also a worldwide source of economic expertise and guidance in designing and using national accounts.

WHILE Third World countries need accounting systems that help them use natural resources wisely, industrialized nations are more immediately concerned with environmental degradation. These nations are faced with increasingly acute pollution, yet they follow an accounting framework that leads to bizarre anomalies.

For example, if toxic substances leak from a dump site and damage soils and aquifers, a nation's measured income does not decline. But if a government spends millions of dollars to clean up the mess, measured income goes up, because such expenditures are considered purchases of final goods and services.

If a firm undertakes the same cleanup itself, income does not rise, because the expenditures are counted as part of the costs of production. But if the site is left polluted and households incur medical expenses, income does rise: the national income accounts treat such costs as final consumption.

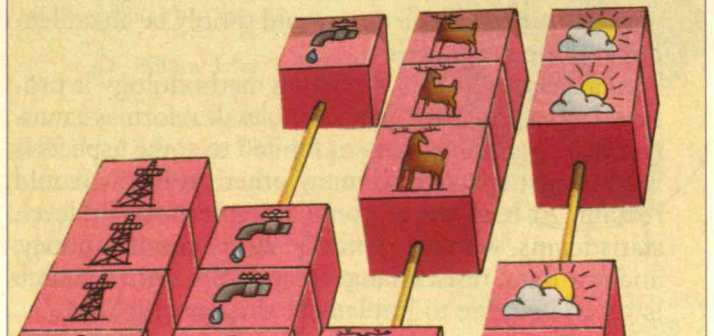
Remedying these inconsistencies is by no means easy. While a clean environment obviously yields goods and services, valuing those benefits is complex. In the first place, ex-

isting national accounts reflect some environmental values, raising the danger of double-counting. For example, agricultural output, yields, and income reflect the "values" of sunshine and precipitation, which make purchased inputs more productive. Increased air pollution reduces agricultural yields, diminishing income in the existing accounts. A glaring omission from the national accounting framework is the value of environmental quality to households.

In principle, damages from worsening pollution, congestion, and noise can be estimated by measuring lost productivity or the willingness of people to pay to get rid of these problems. Yet the task is formidable on a national scale and remains in the realm of research.

Another difficulty is differentiating between outlays to maintain environmental quality and those undertaken for other purposes. When a household buys a water filter or a firm installs a water treatment plant, it's clear that the environment is the problem. But it's not so clear when a household moves to a town with a cleaner environment.

—Robert Repetto ■



Already, the SNA is more complete with respect to natural-resource accounting than the systems most nations derive from it. The framework provides for "reconciliation accounts"—corrections to the main balance sheets that cover changes in the value of natural-resource stocks due to both price shifts and material alterations, such as growth, discoveries, depletion, and extraction. Reconciliation accounts cover not only reproducible assets, such as tree plantations, but also non-reproducible assets, such as farmland and subsoil minerals.

But dissatisfaction with the SNA stems from its many inconsistencies and omissions. For example, it largely fails to look at goods and services outside the market sector, notably those that households produce. Thus, when a person buys an apple pie at the supermarket instead of baking it, national income rises. Also, the SNA ignores important capital assets, such as education and workforce training. Furthermore, it only imperfectly measures goods and services that governments create. It treats as income-generating many activities undertaken only to avert or remedy the disadvantages of modern industrial society, such as pollution (*see the sidebar on page 43*).

These and many other deficiencies have led to a long agenda of suggested improvements, and the U.N. Statistical Commission, advised by a number of expert working groups, is preparing to modify the SNA, as it does once every 20 years or so. However, the commission has evidently already decided to make no fundamental changes, even though deliberations will continue until 1991. Rather, the expert committees have proposed encouraging countries to link natural-resource accounts to conventional national-income measures through "satellite accounts." In other words, natural-resource depletion would simply be an addendum to the main tables.

In a sense, the U.N.'s existing methodology is protected by its very inadequacy: wholesale reform is a massive task, and improvement limited to some aspects is hard to justify when so many other problems would remain. At both the national and international level, statisticians, who are typically short on staff, money, and raw data, resist changes, especially since so much is yet to be done to implement the existing SNA.



Indonesia, like most Third World countries, is threatened by flaws in how economists calculate GNP.

Nonetheless, events of the past decade—such as coastal pollution, tropical deforestation, and the accumulation of greenhouse gases—demonstrate the importance of bringing natural-resource considerations into the main national income accounts as early as possible. Certainly another 20 years is too long to wait for reforms that are already overdue. Only

when the basic measures of economic performance, codified in an official framework, conform to a valid definition of income will economic policies be influenced toward sustainability. While virtually all countries calculate national income accounts, few have implemented past U.N. recommendations with respect to satellite tables because, with limited resources, they have "stuck to the basics." Moreover, politicians, journalists, and sophisticated economists continue to treat the GNP as the prime measure of economic performance. Even the "basic indicators" table that leads off the World Bank's annual *World Development Report* cites GDP, GDP growth per capita, and rate of inflation, but no net figures.

Since the burdens on statisticians are relevant concerns, we instituted the Indonesia study in part to obtain firsthand experience about the effort needed. We found that we could make reasonable estimates from existing information, so compiling and reorganizing it were the main tasks. In this pilot study, without the access to data that a government statistical office would have, a modest effort—some 12 person-months, mostly in the United States—shed substantial light on Indonesia's growth performance over more than a decade.

There is ample time before the U.N. Statistical Office announces a revised SNA to fully explore the implications of extending the concept of depreciation to natural-resource assets. That office should use this time to prepare for a change in the main accounts. Certainly the reforms could be put in place within three to five years.

At the same time, key international economic institutions—including the World Bank, the International Monetary Fund, and the OECD—need to begin to compile, use, and publish figures for net national product and income. And these institutions should ready themselves to assist the growing number of national statistical offices that are deciding to make and use such estimates themselves. ■

Free sample!



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9TCH

The *Bulletin* clock, symbol of the danger of global catastrophe, stands at six minutes to midnight.

*The FDA's
approval of the sweetener aspartame—
and all food additives—leaves many unresolved
questions about their safety
and effectiveness.*

The Price of Sweetness

BY STEVEN A. FARBER



EACH year more than 100 million Americans consume carbonated beverages, iced tea, desserts, and other products sweetened with aspartame. Most of them believe that the artificial sweetener—marketed as NutraSweet—will help them lose weight, or at least avoid gaining weight. They also expect that NutraSweet—bearing the seal of approval of the Food and Drug Administration (FDA)—is natural and harmless. What they do not realize is that there is little concrete evidence showing the sweetener to be safe.

Nearly 200 times sweeter than sugar, aspartame is the most popular low-calorie sweetener available today. By now the vast majority of artificially sweetened soft drinks contain it. It also is sold in granular form as Equal. In 1981 the FDA approved aspartame as a dry substitute for sugar, and by the end of 1982, 23 countries had followed the FDA's lead. Over the past seven years, U.S. consumption of aspartame has increased dramatically, more than doubling between 1984 and 1986 alone.

But FDA approval failed to resolve significant questions both about aspartame's safety and about its effectiveness as a diet aid. Studies conducted by G. D. Searle, the creator of NutraSweet, and submitted to the FDA show that aspartame may induce brain tumors in rats. Later medical studies and reports to the Centers for Disease Control suggest that aspartame may cause a host of side effects in humans ranging from headaches to seizures. Further, recent research into diet and brain chemistry indicates that aspartame does nothing to control weight—and in fact may actually heighten appetite.

The fundamental problem lies in the FDA approval process itself—clear deficiencies in how the agency has handled this case and how it regulates food additives in general. The Food, Drug, and Cosmetic Act, especially as it is now interpreted by the FDA, pays far less attention than is warranted to the hazards of commercial food additives. Food additives are regulated less strictly than prescription drugs, yet are consumed far more casually and by many more people. They are part of food, so people generally assume they are safe. In contrast, people take prescription drugs under medical supervision, expecting there may be side effects. Because food additives can pose a greater health risk, the FDA needs to evaluate them more thoroughly, leaving fewer unresolved concerns about their safety.



ILLUSTRATION: ART SPIKOL

*Aspartame may change
the brain's chemistry, altering people's moods, affecting their diet,
or causing neurologic problems.*

Questions of Safety

Under the Food, Drug, and Cosmetic Act, food additives are evaluated according to two regulatory standards—the general safety clause and the Delaney clause. The general safety clause requires that manufacturers must demonstrate the safety of a food additive before they can market it. (Until Congress added this amendment to the act in 1958 and 1960, the FDA itself had to prove that a new substance was harmful before halting its production.) Historically, the agency has defined “safe” as meaning a “reasonable certainty of no harm,” although it has never spelled out exactly what this definition means. In 1958, Congress added the more specific Delaney clause, which prohibits the FDA from approving any additive shown to cause cancer in people or animals. In the case of aspartame, neither standard has proven adequate to answer questions about safety.

According to advertisements by the NutraSweet Co., which is now owned by Monsanto, the sweetener is as natural as real food. “Your body doesn’t know NutraSweet from beans. Or peas. Or grapes. Or milk. Or chicken for that matter,” promises one commercial.

In a way, this is true: aspartame is primarily composed of aspartic acid and phenylalanine (PHE)—two amino acids that are among the building blocks of all protein. When the body metabolizes aspartame, the additive quickly separates into the amino acids, plus methanol, and the blood carries all three through the body. Methanol can be poisonous ordinarily, but there is little research to show that in this context it is harmful. However, the two amino acids—although “natural”—can affect the body biochemically in a way that is neither usual nor natural. Consuming the amino acids as aspartame is not the same as eating them in milk, meat, or other protein.

One of the most worrisome effects has to do with the chemistry of the human brain, which is protected by a molecular barrier. To enter the brain from the bloodstream, nutrients, including PHE and other ami-

no acids, must travel via transport molecules that act like revolving doors, carrying other substances in and out. These molecules also limit how much of any one amino acid can cross the blood-brain barrier. After protein from a hamburger is metabolized, for example, its 23 amino acids compete for space on the transport molecules.

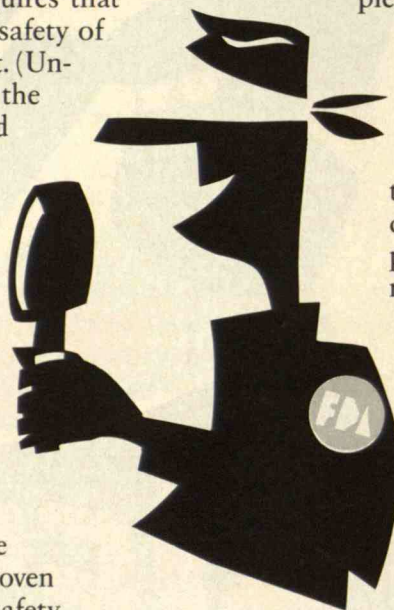
The difficulty is that aspartame consists of only 2 amino acids rather than 23, which means that their level in the blood increases while the amount of other amino acids either drops or remains the same. Thus, competition for space on the transport molecules is less intense, and while the aspartic acid in aspartame does not enter the brain in this manner, the PHE can—in higher concentrations. That’s why a soda sweetened with aspartame can change the brain’s chemistry.

There is still little known about how single amino acids affect the brain. These nutrients are converted into neurotransmitters, chemical messengers that enable the brain to process information. PHE shares the same transport molecule as two other amino acids that are precursors of major neurotransmitters, so an increase in PHE might inhibit the flow of those amino acids to the brain. Although the question of whether aspartame does have this effect remains unresolved, recent research strongly suggests that the additive alters the composition of neurotransmitters. This change in the brain’s chemistry can influence a person’s mood and diet or cause such neurologic problems as seizures or headaches.

People with phenylketonuria (PKU) face more severe problems, because they lack the enzyme that ordinarily degrades PHE. Since high concentrations of PHE can cause brain damage, all products with aspartame bear a warning that they contain the amino acid.

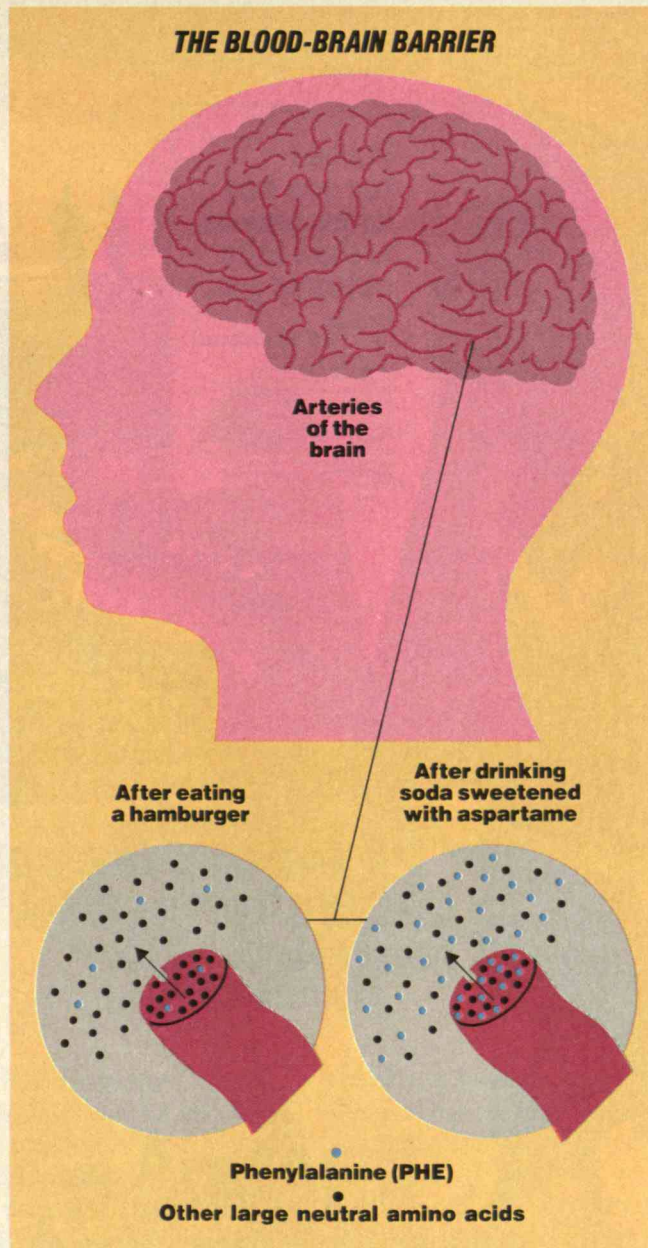
Yet while the label can forewarn those aware that they have PKU, it may not help the estimated 10 million people who are carriers but may not know it. With the gene for PKU on just one chromosome rather than two, they do not have the actual symptoms. Even so, they cannot degrade PHE as effectively as normal individuals and may be sensitive to increased levels in their diet.

Another serious question about aspartame is whether it induces brain tumors in rats—and therefore



STEVEN A. FARBER is a master's candidate in the Technology Policy Program and a PhD candidate in brain and cognitive sciences at MIT.

THE BLOOD-BRAIN BARRIER



"Transport molecules" in the cells of artery walls carry a class of amino acids including PHE into the brain. Eating aspartame can increase the concentra-

tion of PHE, which in large amounts can be toxic, and decrease the amount of other amino acids of this class—the precursors of neurotransmitters.

potentially in humans. As part of the FDA approval process, in the 1970s G. D. Searle conducted a series of safety studies on test animals, looking for possible side effects of aspartame, including brain tumors. Worried about flaws in how the experiments were carried out, the FDA conducted an extensive inquiry that involved three separate investigations under four FDA commissioners. The inquiry ultimately showed that Searle's studies were inconclusive, and that aspartame may indeed contribute to brain tumors (see the box on page 53).

In addition to the errors the investigations exposed, the tumor studies suffered from weaknesses in their statistical design. For example, the number of animals treated with aspartame was too small to detect a low incidence of tumors. But because so many people consume aspartame, even a rare side effect can have widespread results. With 100 million people using the sweetener, an increase of one-tenth of 1 percent in the incidence of tumors could harm 100,000 people.

Concerned that the studies were not sensitive enough to detect tumors possibly caused by aspartame, Satya D. Dubey, FDA chief of the Statistical Evaluations Branch, wrote to the FDA commissioner's office in May 1981 saying research "should not be considered confirmatory for decision purposes." But despite the numerous unanswered questions and contradictory conclusions from the various investigations, two months later then-Commissioner Arthur H. Hayes approved aspartame.

By July 1988, the FDA had received more than 6,000 complaints about side effects from the sweetener. The most frequently reported symptoms have been neurological, mainly headaches, but they also range from changes in mood to seizures. Few consumers realize they can notify the FDA, and so far any widespread problems these complaints might represent remain relatively invisible.

Suppose, for instance, that 2 of every 10,000 people who consume aspartame have a seizure—a plausible number given the usual incidence of seizures. This would mean that in 1987, when 70 million to 100 million people drank beverages sweetened with aspartame, there might have been as many as 20,000 new victims of seizures. The 67,000 physicians in general practice would each, on average, have seen less than 1 of these hypothetical patients. If all of them were referred to only 5,000 neurologists who specialize in seizures, each would have treated a mere 4 additional patients that year—not a noticeable number.

A massive—and prohibitively expensive—survey no doubt could answer questions about the side effects of aspartame. It is hardly likely that such a survey will be done, and nor would it be practical. This leaves millions of consumers who eat the sweetener facing a possible risk.

A Diet Dilemma

Any food additive can involve some uncertainty—a chance that individuals may choose to take if they feel the benefits are worth it. But just as the FDA review

"I have a weight problem. I can't wait for dessert."

"The secret, the real, the best, the main course... it's like one big dessert course is finally got to what I'm really craving. No... dessert. As long as it's a calorie-free Jell-O. Free Jell-O? Great. And it's so delicious, and it's so much better than... well, it's better than the rest."

Jell-O

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The dessert you don't have to desert.

Discover two new long lasting reasons to chew Extra[®] sugarfree gum.

Introducing Winter Fresh[™] and Cinnamon

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Extra

Why Shari Simon Buys Her Favorite Cola By The Case.

DIET RITZ

Why So Many Things Taste So Good.

NUTRASWEET

Just Look For The Swirl.

YOU'VE JUST DISCOVERED A DELICIOUSLY FRUITY YOGURT WITH THE LOWEST CALORIES PER OUNCE. CONGRATULATIONS.

Weight Watchers[®] ULTIMATE 90

YOGURT ENRICHED WITH NUTRASWEET[®] SUGARFREE SWEETENER

STRAWBERRY

Weight Watchers[®] This is party.

If You Want To Taste Something Truly Sensational, Just Look For The NutraSweet[®] Swirl.

Look For The Swirl On These Fine Products, Too:

Reckitt's Sugar Free Bullseye[®] Diet Adirondack[®] Soda Cooler Dole[®] Fresh Lites[®] Drink Aid Sugar Free Easy Treats[®] Kemp's Kooler Lite[®] Laura Lynn[®] National[®] Instant Hot Cocoa Mix NuSystem Cuisine Gelatin Dessert Mix

NUTRASWEET

THE RICHNESS OF REAL CHOCOLATE MOUSSE NOW ON A STICK AND ONLY 35 CALORIES.

Weight Watchers[®] CHOCOLATE MOUSSE

Weight Watchers[®] This is party.

Despite the optimistic claims in some ads, research suggests that aspartame does not help in weight control—and can even trigger a craving for carbohydrates.

*The FDA
regulates food additives less strictly than prescription drugs,
although they are not necessarily safer.*

did not appease concerns about aspartame's safety, it also did not answer questions about whether the sweetener is effective. That is, does aspartame help people control their weight? A growing body of research suggests that the answer is no.

Under the Food, Drug, and Cosmetic Act, food additives must fulfill their intended "technical effect." A flavoring must change a food's flavor; a preservative must preserve it. But the FDA interprets this requirement narrowly for artificial sweeteners. It assumes that food with few or no calories is useful in controlling weight and demands only that sweeteners taste sweet. So the FDA allows products containing a sweetener to be labeled "diet" without requiring that they actually help people on a diet.

In its February 1985 newsletter *FDA Consumer*, however, the agency itself implied that aspartame does not help control weight. It reported that while most diet drinks contain no calories—compared with 150 calories in a regular 12-ounce soft drink—"there is little documented evidence that consumption of artificially sweetened foods has contributed to weight loss among Americans."

In fact, no studies show that average consumers who supplement their normal diet with aspartame either lose weight or maintain their current weight. The research, carried out over the last 10 to 15 years, is not entirely consistent. Some experiments show that eating aspartame does not help people lose weight at all. For example, in one study conducted at Harvard University by Robert H. Knopp and colleagues, overweight women and men were given either aspartame or lactose (a natural sugar) in gelatin capsules. The average weight loss for the group given aspartame did not differ significantly from that of those eating sugar.

On the other hand, Katherine P. Porikos, then of St. Luke's Hospital, conducted studies in which obese subjects who ate aspartame in place of sugar in high-calorie foods did end up consuming fewer calories. Still, these results are misleading, because although the subjects were allowed to eat as much as they wanted to regain the calories they lost by

substituting aspartame for sugar, they were prohibited from eating certain foods. For instance, they could eat food relatively low in calories, like potatoes, but not high-calorie desserts. So while they managed to compensate for about 40 percent of the lost calories, doing that required eating an enormous amount of food, more than they would eat under ordinary conditions. If they could have eaten any food at all—like cake made with sugar—they might well have easily made up for all the lost calories.

Other research even suggests that aspartame might stimulate people to want more carbohydrates—and subsequently gain weight. John E. Blundell and Andrew J. Hill of the University of Leeds have compared how full people feel after drinking plain water and water sweetened with either sugar or aspartame. They have found that subjects given the sugar drink have dramatically less urge to eat carbohydrates. Subjects given aspartame report feeling fuller than they

do after drinking plain water, but they also feel a stronger desire to eat carbohydrates. Like several other studies, this work suggests that aspartame can trigger a craving for carbohydrates.

While such research does not prove that aspartame causes people to gain weight, it makes it clear that the sweetener certainly has not been proven to keep weight in check. But if aspartame contains no calories, how can this be true? One explanation could be that eating is a complex process that cannot be fooled by artificial sweeteners.

Although people generally think they choose what they eat, studies show that both humans and rats consume carbohydrates and proteins in a constant ratio. They seem to have an internal system that regulates their diet. According to one hypothesis, this regulatory mechanism involves changes in the brain's level of tryptophan, an amino acid that is the precursor of the neurotransmitter serotonin, which affects eating behavior.

Ordinary food both sends taste signals to the brain and changes the brain's chemistry. Sweeteners that contain few calories separate the taste signals from the biochemical changes. For example, if we eat a wedge of chocolate cake, which is rich in carbohydrates and contains little protein, the level of tryptophan in our brain increases. This in turn



raises the amount of serotonin, which regulates the proportion of protein and carbohydrate we eat. The rise in serotonin usually causes us to stop wanting carbohydrates. Cake sweetened with aspartame rather than sugar will not have the same result.

Moreover, some individuals find that eating carbohydrates—and increasing the serotonin in their brain—simply puts them in a better mood. If they eat aspartame instead, the food clearly will not do the trick, and they will be inclined to eat more.

Finally, data from the U.S. Department of Agriculture suggest that rather than consuming aspartame instead of carbohydrates, which would help them lose weight, many people simply add the sweetener to their usual diet. Because their craving for carbohydrates does not subside—as it might with a sugary drink—they are likely to eat a candy bar an hour after they finish their diet soda.

Both the FDA and the Federal Trade Commission, which is concerned with the advertising and sale of products, are charged with protecting consumers from deception. The Federal Trade Commission Act also prohibits outright lies or even deceptive innuendo in advertising. Yet although aspartame may actually stimulate appetite and bring on a craving for carbohydrates, neither the FDA nor the Federal Trade Commission has evaluated the product's implicit claim that it will keep people from overeating. Few consumers realize that sodas containing the sweetener, which are usually labeled "diet," may not help them control their weight.

Aspartame is used in hundreds of products, ranging from soda to cereal to gum.

Several dozen vitamins, particularly children's, also contain the sweetener.

A Safer System

The FDA's approval of aspartame reflects the agency's failure to implement the Food, Drug, and Cosmetic Act. It also illustrates inadequacies in the law itself. Although there is no scientific evidence that food additives are always safer than prescription drugs—and although people use such additives more widely and casually—the law regulates them less strictly.

Drugs are taken under safer conditions than food additives. Doctors prescribe specific doses, taking into account a patient's age, race, gender, and medical history. When people use medication, they usually are aware that there might be side effects, so if they develop a reaction to the drug, they can get medical attention.

Before a new drug can be approved, the FDA often consults with an advisory committee of scientists, a consumer advocate, and industry representatives to get information about possible adverse effects. Drugs are tested on humans, which offers a

measure of protection from substances that may influence people differently from test animals. And a company must show that the drug is not only safe but effective.

Finally, the process of drug approval has a built-in monitoring system. After a new drug is released, the company must track its use and report any harmful side effects to the FDA. Although this post-market oversight stops short of actively surveying consumers, it acknowledges—rightly—that every drug has some risk.



Aspartame's Tangled History

Food additives, on the other hand, are consumed at a wide range of doses by millions of people who are not under medical care. People generally assume their food is safe and do not link it with health problems that might follow.

All the food additives we eat are tested based on their predicted dose and molecular structure—those with new chemical configurations are tested more carefully. Additives suspected to be the least risky undergo only short-term trials, and even those regulated most strictly are tested just with animals. Thus, a new food additive can be approved and consumed by millions of people without ever having undergone controlled clinical trials with humans.

To avoid problems like those with aspartame, the FDA needs to distinguish among different classes of food additives. While additives such as coloring from natural sources might be regulated under the present system, novel additives like aspartame that have a new molecular structure and drug-like properties should be treated more like drugs. This latter group would require clinical tests to evaluate efficacy as well as safety. Advisory boards could help identify possible risks, weigh potential benefits, and provide a mechanism for follow-up after the additive has been marketed. The approval process should determine whether the additive is necessary, given that other safe substitutes may be available.

While the companies themselves—which have a substantial financial interest in the product—currently perform safety testing, a better system would use FDA-licensed laboratories to do some of this research. The companies would carry out additional tests as well—clinical trials of the product in combination with other food and drugs, such as caffeine. Each study would be designed and evaluated based on the numbers of people expected to consume the substance. An additive that half the population might eat would require more stringent testing than one directed at a smaller group.

Historically, changes in the food and drug law have been spurred by body counts following calamities. Congress passed the 1938 Food, Drug, and Cosmetic Act, for example, largely in response to 103 deaths from a cure-all known as the elixir sulfanilamide. The FDA, which quickly determined the cause of the deaths, lacked the legal authority to take any action—a deficiency Congress shortly addressed. Today Congress and the FDA need to similarly address the weaknesses and inconsistencies remaining in the Food, Drug, and Cosmetic Act—without waiting for a disaster. ■

IN 1965, G.D. Searle chemist James Schlatter was synthesizing compounds, hoping to find a treatment for ulcers. After splashing his hand with his latest creation, he inadvertently licked a finger as he moved some lab paper and discovered that the new substance tasted intensely sweet. He had just invented aspartame.

Aspartame's tangled regulatory history began in 1973 when the FDA gave Searle the go-ahead to produce the artificial sweetener. But the agency soon expressed concern about the authenticity of the company's safety studies, and Searle voluntarily suspended marketing.

Over the next seven years, the FDA investigated both Searle and aspartame to answer basic questions about the sweetener's safety. Court documents, documents gathered by attorney and food-safety advocate James Turner, and interviews with FDA policymakers and scientists show that the safety studies were carelessly executed and yielded contradictory results.

The FDA first formed an internal task force to review Searle's studies. Led by FDA scientist Carlton Sharp, in 1976 this team reported that Searle had withheld important information. It described "an attitude of disregard for FDA's mission of protection of the public health by selectively reporting the results of studies" and "a pattern of conduct which compromises the scientific integrity of the studies."

A subsequent review by FDA Bureau of Foods scientists found significant errors in Searle's data, results that appeared to have been falsified, and questionable lab practices. For example, the data submitted to the FDA differed from the original data gathered at Searle. The report described instances in which Searle miscounted or apparently lost test animals. In one case, a study reported that a particular scientist had examined 329 animals

in two days, although the same scientist later told the FDA that he could only examine 30 in a single day. One of the most serious findings suggested that researchers cut tumors from animals in certain test groups while leaving the control group untouched.

These findings spurred the FDA's chief counsel, Richard Merrill, to ask that the Justice Department convene a grand jury to investigate Searle "for concealing material facts and making false statements." Within two years, however, two senior prosecutors from Chicago who were assigned to the case joined the law firm Sidley and Austin, which represented Searle. A grand jury was never created.

As part of the long investigation, in 1977 Searle itself hired an independent research group, Universities Associated Research and Education in Pathology (UAREP), to review 12 sets of animal studies. Because of FDA requirements, UAREP was not allowed to examine the design of the experiments—only the conclusions Searle scientists drew from the data—but it nevertheless decided that the errors the FDA task force found did not affect the research results.

Still unsatisfied, in 1980 the FDA and consumer advocates, together with Searle, selected a panel of three scientists from outside the FDA to assess aspartame's safety—the first and only "science court" ever held in the United States. The panel, chaired by MIT professor Walle J. Nauta, recommended keeping aspartame off the market until further animal tests could show that it did not cause tumors. But this was simply one of the many recommendations that FDA Commissioner Arthur H. Hayes, who approved the sweetener, chose not to heed. Within one month of the approval, Hayes left the FDA, and three months later he joined Burson-Marsteller, the advertising agency that handled Searle's account.

—Steven A. Farber ■



*A TREATY TO CUT
LONG-RANGE NUCLEAR
WEAPONS IS AT HAND,
BUT CONTROVERSY
OVER KEY PROVISIONS
COULD STILL
BLOCK AGREEMENT.*



FINISHING START

THE SUPERPOWERS CLOSE IN
ON REAL ARMS CONTROL

GEORGE Bush has continued the warming trend in U.S.-Soviet relations established by Ronald Reagan and Mikhail Gorbachev. But progress toward reducing nuclear arms—formerly the centerpiece of the new détente—has been slow. The strategic arms reduction talks (START) in Geneva remained stalled through most of 1989, with the new administration giving the negotiations a low priority. Last fall both sides made concessions that apparently broke some logjams, raising hopes that START may now move more quickly toward completion. But key disputes have been finessed rather than

BY PETER A. CLAUSEN

*President George Bush, Soviet Foreign Minister
Eduard Shevardnadze, and Secretary of State James Baker celebrate
arms-control concessions in September.*

resolved, and START could yet face new troubles down the road, at the bargaining table or in the Senate ratification process.

At stake is an agreement of far greater significance than the 1988 treaty eliminating U.S. and Soviet intermediate-range nuclear forces (INF). START tackles the weapons at the heart of the nuclear arms race, the "strategic" or long-range forces that each superpower targets at the other's territory. These forces account for about half the 50,000 nuclear weapons that the two countries possess. The proposed treaty would reverse the growth of strategic arsenals for the first time since the nuclear arms race began, returning them to the levels of about 10 years ago. START would cut much deeper than the SALT agreements of the 1970s, which only placed ceilings on still-burgeoning forces.

START's major provisions, which negotiators have already agreed on, include significant cuts in several key areas:

- A ceiling of 1,600 on delivery vehicles—intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and long-range bombers. The United States now has about 2,000 such weapons and the Soviet Union about 2,500.

- A ceiling of 6,000 on the nuclear warheads these delivery vehicles carry, now numbering about 13,000 and 11,000 for the United States and the Soviet Union, respectively. In practice, warheads would exceed 6,000 because of special counting rules applied to weapons carried by bombers, but the cut would likely still amount to about 30 percent.

- A sublimit of 4,900 ballistic-missile warheads within the 6,000-warhead ceiling. This would mean a cut of about 50 percent for the Soviet Union and 37 percent for the United States.

- A 50 percent cut, from 308 to 154, in the most powerful and accurate Soviet missiles, the SS-18 "heavy" ICBMs, and a ceiling of 1,540 on the warheads they carry.

- To verify compliance, extensive on-site inspections, building on and expanding the INF Treaty precedents.

These terms are particularly favorable to the United States. The rollbacks focus on the weapons it deems most threatening—ballistic missiles and their

warheads—while treating bomber weapons, where the United States holds a large advantage, more leniently. Halving the Soviet SS-18 missile force, for example, would help reduce the vulnerability of America's land-based missiles, easing a problem that has plagued U.S. defense policy for more than a decade. And the on-site inspections provided by START are a major gain for the United States.

Failure of the START negotiations, in contrast, would set back both superpower relations and U.S. security. The stakes are all the higher because of the double-edged legacy of the Reagan years: remarkable progress toward arms cuts combined with a severe erosion of the SALT and Antiballistic Missile (ABM) treaties of the 1970s. In effect, the superpowers are working without a safety net—they must either go forward with START or slip back to an unregulated and unpredictable nuclear arms race.

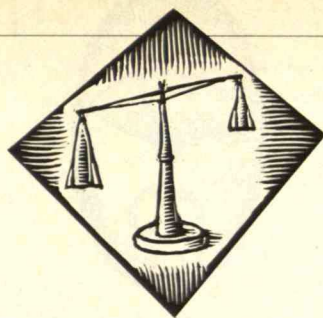
The latter outcome would be costly for the United States. If START fails, Soviet strategic forces will be free to expand without external limits. Soviet nuclear forces have grown more than those of the United States during the 1980s and could continue to do so, despite the USSR's economic difficulties. With its own budgetary constraints, Washington is hardly bargaining from commanding strength. And without the cooperative verification measures provided by START, the United States would find it much harder to monitor new Soviet weapons such as mobile missiles. Without START, in short, U.S. defense planning would become more difficult, expensive, and politically contentious.

But despite strong public support for cuts in nuclear weapons, the nuclear-policy establishment, represented by national security advisor Brent Scowcroft and other administration figures, remains skeptical of their wisdom and wary of their impact on U.S. strategic forces. START thus presents President Bush with a double challenge. To complete the treaty, he will have to forge compromises on the remaining U.S.-Soviet disputes and allay misgivings at home. In the process, START offers an opportunity to bring coherence to U.S. policy in areas where it has been lacking, notably the Strategic Defense Initiative (SDI) and the future of America's land-based missiles.

The Star Wars Connection

Former President Reagan's plan for a "Star Wars" shield against missile attack has bedeviled START from the beginning. The Soviets, asserting traditional arms-control wisdom, have argued that nuclear cuts require strict limits on antimissile systems such as

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SDI. Without such limits, each superpower would inevitably expand its offensive forces to overcome the other's defensive shield. Thus, the Soviets have sought to curtail SDI, insisting that compliance with the 1972 ABM Treaty—which restricts antimissile testing and allows only a token deployment of 100 interceptor rockets—be reaffirmed as a condition of START.

The United States, seeking a free hand on SDI, has stubbornly resisted this link. American negotiators have tried without success to promote a new arms-control framework under which defenses would be phased in as offenses are reduced. The United States has also advanced a reinterpretation of the ABM Treaty that would sanction SDI tests in space—tests that both parties had previously considered banned.

In September Moscow agreed to defer resolution of this dispute while the two sides complete and implement START. The Soviets also announced they would unconditionally dismantle the Krasnoyarsk early-warning radar, which violates ABM Treaty siting requirements for such installations. But the Soviets still insist that either side could withdraw from START if the other violates the ABM Treaty, and they want a joint “understanding” on this point. Thus, although resolving these questions is no longer a precondition of START, a treaty on nuclear cuts would remain fragile without an eventual agreement on SDI.

The recent Soviet shift can be seen as either a grudging concession to U.S. firmness or a shrewd tactic to further hamstring a Star Wars program whose political and budgetary support has shrunk dramatically in the last year. Reagan's vision of an “umbrella” defense of the American population has given way to a plan designed to enhance deterrence by protecting U.S. nuclear forces against a Soviet first strike. But it is doubtful that the United States will deploy even this limited antimissile system and the new Soviet position may make such a move even less likely.

In effect, Moscow's stance would force the United States to eventually choose between scuttling a START agreement and deploying SDI. START would almost certainly prevail, and not only because it

would save money. According to the joint chiefs of staff, a “phase-one” SDI system would be designed to intercept 50 percent of the highly accurate Soviet SS-18 missiles. However, START would accomplish the same result while also removing thousands of other Soviet warheads aimed at the United States and sparing both sides the costly arms race SDI would unleash. In short, START offers a more effective, direct, and inexpensive way to cut the Soviet missile threat.

But the matter may not prove so easy to finesse, since the two sides still differ on what kinds of antimissile testing the treaty allows. While the dispute may seem largely academic given SDI's practical limits, neither side is likely to be comfortable cutting its nuclear forces while the rules governing antimissile systems remain vague and contentious. An “agreement to disagree” could even imperil Senate ratification of the treaty. Hardline SDI supporters

will argue that the Soviets have been given a veto over the program's future. Others, including Senate Armed Services Chairman Sam Nunn and the joint chiefs of staff, worry that ABM ambiguity may work to the Soviets' advantage. With an antimissile system already around Moscow (permitted by the treaty) and a large air-defense network, the Soviet Union is better positioned to field a nationwide shield if the ABM Treaty is weakened or scrapped. Mindful of this, the joint chiefs have counseled against insisting on the right to deploy SDI.

In the final analysis, a healthy ABM Treaty is a crucial backstop to START. Reviving the treaty is a two-fold task. First, the superpowers must reconfirm the traditional interpretation—that the agreement bans developing, testing, and deploying space-based ABM systems and components. Second, they will have to decide how the treaty applies to defensive technologies—such as directed-energy weapons and infrared sensors—that have been developed during the past decade. Several key issues need to be resolved, including the difference between ABM “components” (which cannot be tested) and “sub-components” or “adjuncts” (which can), the power levels and other performance attributes that the treaty prohibits, and the meaning of testing in an “ABM mode.”

*D*ESPITE
A TREATY THAT
FAVORS THE U.S. AND
STRONG PUBLIC
SUPPORT FOR CUTS
IN NUCLEAR WEAPONS,
THE POLICY
ESTABLISHMENT
REMAINS SKEPTICAL.

Curbing Cruise Missiles at Sea

Control of sea-launched cruise missiles (SLCMs)—low-flying, jet-powered missiles launched from surface ships or submarines—has been a second key stumbling block to a START agreement. SLCMs are inherently difficult to control because they are much smaller and more easily concealed than ballistic missiles, and because identical missiles can carry either nuclear or conventional warheads.

Although both sides have agreed in principle to set limits on SLCMs—apart from the START ceilings on strategic warheads and delivery systems—in practice only the Soviets have pressed the issue. As with SDI, the Soviet position on SLCMs has softened over time, from a demand for banning them outright to various proposals for limiting their numbers and restricting them to certain classes of vessels. Most recently, Moscow indicated that SLCM controls could come under a separate agreement and need not be part of START itself.

The United States, which leads in SLCM technology, has opposed any formal limits and proposed that each side simply declare the size of its intended SLCM force. The U.S. Navy wants SLCMs available for use both against Soviet targets and in regional conflicts; it plans to deploy about 3,400 land-attack SLCMs, of which about 750 are to be nuclear-armed. The United States also argues that verifying a limit on nuclear SLCMs would require inspections of such scope and intrusiveness as to be infeasible. The Navy is especially opposed to on-ship inspections, fearing that they could compromise military secrets, interfere with operations, and jeopardize America's "neither confirm nor deny" policy on the presence of nuclear weapons on specific vessels.

But unrestricted proliferation of SLCMs would leave a gaping loophole for circumventing a START treaty and—as with SDI—the United States stands to gain more from limits than the Soviets. Because of its extensive coastline, the United States is especially vulnerable to a sea-based cruise-missile threat. Even though this country temporarily holds the lead in these weapons, many analysts believe that SLBMs will offer the Soviet Union a net advantage by posing a new threat of surprise attack against U.S. and



THE START TREATY WOULD REVERSE THE GROWTH OF LONG-RANGE NUCLEAR ARSENALS FOR THE FIRST TIME SINCE THE ARMS RACE BEGAN.

NATO coastal cities, military bases, and command centers.

Moreover, SLCMs threaten the stability of the nuclear balance because they blur the lines between conventional and nuclear conflict, and between tactical and strategic weapons. Deployed globally on vessels with diverse missions, they would increase the danger of escalation (whether deliberate or from misperception and miscalculation) during regional conflicts and superpower crises. Future cruise missiles—longer-range, faster, and more "stealthy"—will be even more destabilizing.

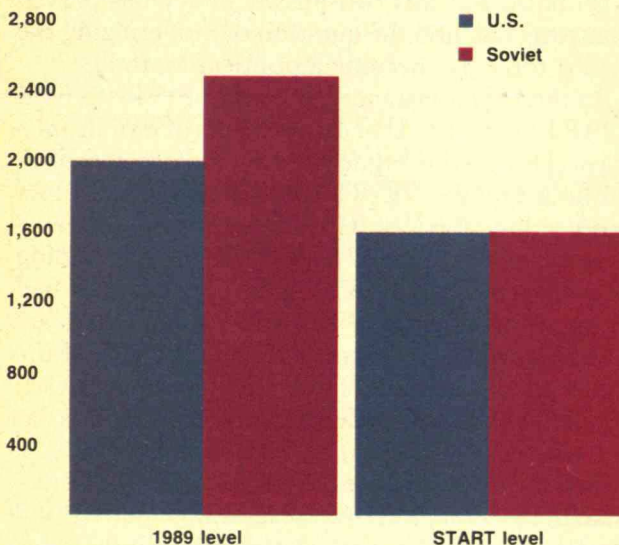
If the United States does rethink its blanket opposition to SLCM controls, verification—while difficult—should not be an insuperable problem. On-site monitoring of SLCM production could help, as would tamper-proof "tags" and "seals" that identify legal missiles and prevent a country from converting conventionally armed missiles to nuclear ones. Inspections during deployment and maintenance could verify that neither side had introduced illegal missiles. Radiation-detecting devices could also help determine whether an SLCM is armed with a nuclear warhead. A team of private American scientists tested such a device aboard a Soviet ship just last July.

A total ban on both conventional and nuclear SLCMs—like the INF ban on ground-launched cruise missiles—would be easiest to verify. If only nuclear SLCMs are controlled, as the United States has so far insisted, an agreement would need to guard against converting conventional missiles to nuclear ones. That task would be eased if nuclear SLCMs were prohibited altogether. A numerical ceiling on nuclear SLCMs would require the most intensive verification, but even here, schemes have been proposed to avoid the highly intrusive shipboard inspections that most disturb the U.S. Navy.

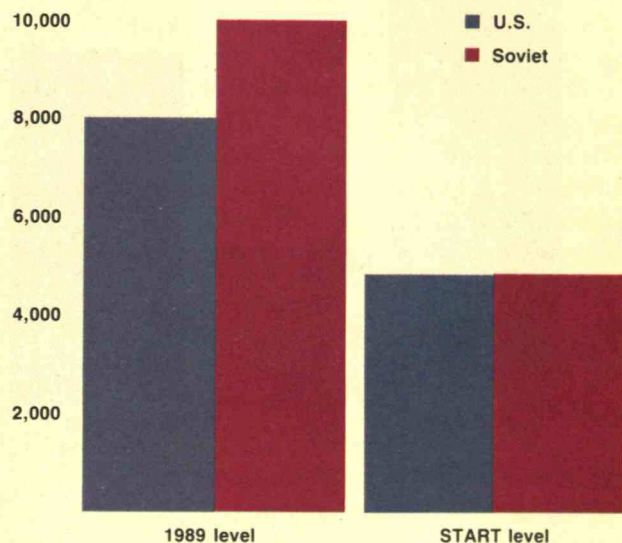
A more comprehensive approach to resolving the SLCM dispute deserves mention. Proposed last year by Paul Nitze, the Reagan administration's top arms-control advisor, it would ban all sea-based nuclear weapons except for submarine-launched ballistic missiles. Such a ban would be easier to verify than limits on nuclear cruise missiles alone, since any nuclear weapon—regardless of type—aboard a sur-

The proposed treaty would eliminate Soviet advantages in ballistic-missile warheads, as well as in long-range bombers and missiles that deliver nuclear weapons.

Delivery Vehicles
(Ballistic missiles and bombers)



Ballistic-Missile Warheads



face ship would constitute a violation. The United States would benefit from such a ban since it would reinforce U.S. superiority at sea by removing Soviet nuclear weapons from the equation.

START is unlikely to see a solution to the SLCM problem. But failure to lay the groundwork for controlling these weapons could continue to block the treaty's completion while harming U.S. security in the long run.

The Mobile Missile Mire

A third major START dispute concerns the status of land-based ICBMs deployed on mobile launch vehicles, such as trucks or rail cars. President Bush has reversed a U.S. demand for a mobile-missile ban, but only if Congress funds such weapons. Thus the fate of START has become linked to the unruly politics of U.S. ICBM modernization, a potential source of future trouble for the treaty.

The appeal of mobile ICBMs is that they are less vulnerable to attack than missiles based in fixed silos. The latter have become increasingly at risk as long-range missiles have become more accurate, with a resulting decline in stability. The danger is that ICBMs might invite preemptive attack, or be fired hastily to avoid preemption, during a severe crisis. By reducing these first-strike pressures, mobile ICBMs could remove a possible trigger for nuclear war.

Although it had formerly endorsed this logic, the

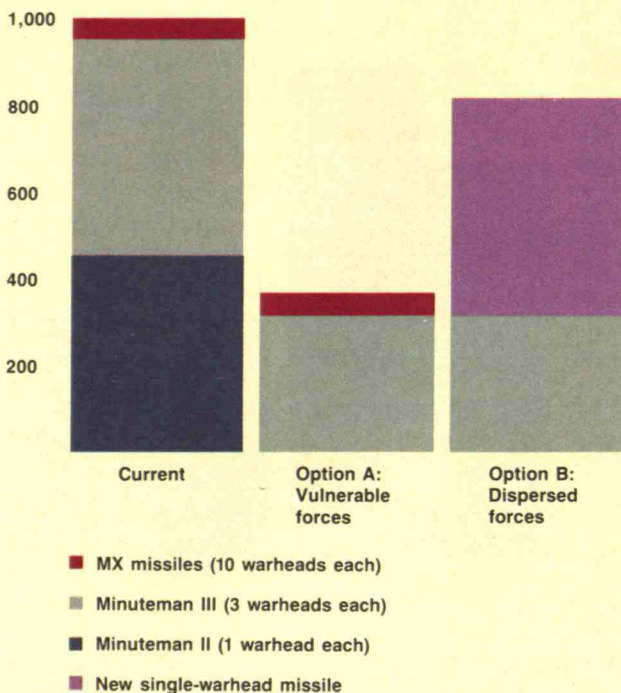
United States abruptly called for a START ban on mobile ICBMs in 1985, citing verification problems as the reason for the switch. Another likely cause was the unequal success of the two superpowers in fielding mobile missiles. The Soviets have begun deploying both the single-warhead SS-25 (towed by truck) and the 10-warhead SS-24 (carried by rail car). U.S. mobile-missile plans, in contrast, have repeatedly sparked controversy, and this country has not yet deployed any. Two types, the single-warhead Midgeman and a rail-based version of the 10-warhead MX (now based in silos), are being developed.

Now that the United States has withdrawn its demand for a ban on mobiles, the two sides are working on ways to verify a ceiling—more difficult than for silo-based weapons. Mobile ICBMs would be limited in numbers and confined to restricted areas. With advance notice to the other party, either side would be permitted to disperse the missiles beyond these areas for training, maintenance, and exercises. Periodic displays, such as opening the roofs of launcher buildings, would aid counting by satellites. Following the precedent set by the INF treaty, some production facilities would be subject to continuous monitoring. Supplies of spare missiles would also be regulated to protect against rapid “breakout” from treaty ceilings.

But despite this progress, the issue has not been put to rest. Key congressional leaders have echoed Bush's position, saying that they will not back a START agreement without firm funding for U.S. mo-

U.S. Silo-Based Missiles after START

No. of missiles/silos



U.S. analysts are wrestling with how to cut U.S. nuclear warheads while retaining a missile force that could withstand a Soviet attack. Options A and B would each eliminate about 1,000 ICBM warheads from U.S. missiles. But A produces a vulnerable force concentrated in only a few silos. B—a better solution—leaves more silos than the Soviets could target with their highly accurate, post-START SS-18 missiles.

biles. Such demands could endanger the treaty, since U.S. mobile-missile plans have drawbacks and support for them is shaky.

The Midgetman would be towed by trucks based on government land. On warning of attack, the missile-laden trucks would quickly disperse, and could be destroyed only by an impractically large Soviet barrage attack of their entire dispersal area. Although this scheme would be highly survivable, it is expensive; recent estimates place its cost at about \$25 billion.

The MX plan would be much cheaper but has other liabilities. Missile-carrying trains, based in a few garrisons, would fan out onto the national rail system in times of crisis. But the trains would require several hours' warning time to disperse enough to avoid attack, and would be very vulnerable without such warning. Moreover, release of the trains could itself escalate a crisis, as well as create risks of acci-

dent or sabotage.

Asked by Congress to choose between the two plans, President Bush last spring decided to proceed with both. But this two-missile policy has proven controversial, and the question of modernizing the ICBM force has become a political football.

In these circumstances, it could be risky to hold START hostage to U.S. deployments of mobile missiles. Those who argue for this linkage fear that without mobiles START could actually result in a more vulnerable U.S. ICBM force. This has been a major concern of many START skeptics, including Scowcroft and Henry Kissinger. The fear is rooted in an unfortunate fact: U.S. silo-based ICBMs are ill-suited for simple numerical cuts because of the trend toward placing more and more warheads (known as multiple independently targetable reentry vehicles, or MIRVs) on each missile. The U.S. ICBM force contains the old single-warhead Minuteman II, the newer three-warhead Minuteman III, and the 10-warhead MX, the most recent addition. If the United States cut back to START warhead levels by retiring its oldest missiles, it would wind up with its remaining ICBM warheads more tightly concentrated—and thus more vulnerable—than at present.

To avoid this outcome, the United States does need to disperse its remaining weapons more widely as START cuts proceed. But while mobile missiles would accomplish this goal, they are not essential. An alternative strategy is to begin to "deMIRV" American missiles as their numbers are cut. Under this approach, ICBMs would remain in fixed silos, but the average number of warheads that each carry would be reduced.

DeMIRVing would allow the United States to eliminate large numbers of warheads while reducing only slightly the number of silos the Soviets would have to target to destroy U.S. ICBMs. Combined with the START-imposed 50 percent cut in Soviet SS-18s (the only Soviet missile accurate enough to qualify as a "silo-killer"), the result would be a significantly more survivable force. DeMIRVing could be accomplished in several ways: by retiring multiple-warhead missiles first, beginning with the MX; by "downloading" warheads from the Minuteman III, making it a one- or two-warhead missile; or by deploying new single-warhead missiles in existing U.S. silos.

The main objection to this approach is that it may give only a temporary reprieve to silo-based missiles. The "window of vulnerability" could reopen as more Soviet missiles, including those based on submarines,

become as accurate as the SS-18. Further missile cuts and testing limits would help head off this threat. But the United States could also hedge against it by fielding a single-warhead silo-based missile that could be made mobile later.

For example, a post-START force might consist of some 500 silo-based versions of the Midgetman and about 300 Minuteman IIIs. This option would cut more than 1,000 U.S. warheads while eliminating only 200 missile silos. The resulting force would be spread over 800 silos—more than could be destroyed by the Soviet SS-18 missiles remaining after START. Should the United States decide that it requires a mobile ICBM in the future, it could redeploy the Midgetman on trucks. In the meantime, it would reap immediate gains in ICBM survivability under START while avoiding the expense and controversy of deploying mobiles.

Beyond START

Behind much of the specific criticism of START lies a more diffuse concern—fear that the treaty will put the West on a slippery slope to “denuclearization,” eroding the postwar foundations of deterrence and stability. This concern owes as much to the rhetoric of nuclear “abolitionism” promoted by Reagan and Gorbachev as to the actual provisions of the START treaty. It also reflects a conviction that further nuclear-arms reductions should be deferred until Soviet conventional forces in Europe are cut back.

These fears are misplaced. START reductions will require no basic change in U.S. deterrence strategy; both sides will still have more than enough nuclear firepower to guarantee “mutual assured destruction” and therefore discourage the other side from attacking first. Nor does START erode the U.S. nuclear guarantee of Western Europe’s security. In fact, the NATO allies strongly endorse rapid progress to complete START. The argument for holding START hostage to conventional-arms reductions wrongly implies that the treaty weakens the West’s nuclear position. But the terms clearly favor the U.S.

Nevertheless, while the treaty does not in itself fundamentally challenge the nuclear status quo, it *is* a first step toward rethinking our reliance on nuclear



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weapons. More deep cuts should follow. Equally important are measures to slow the momentum of weapons modernization to head off new destabilizing trends. Significantly, two of the main roadblocks to START—controls on sea-launched cruise missiles and space weapons—are the result of technological “end runs” around the SALT and ABM agreements. By the same token, a START treaty could be undermined if future modernization remains unconstrained.

An agenda for post-START nuclear arms control should include:

- A further 50 percent reduction in strategic weapons.
- A phaseout of MIRVed ballistic missiles, in favor of less provocative and destabilizing single-warhead missiles.
- Tight constraints on testing nuclear weapons and new ballistic missiles.
- A ban on testing antisatellite weapons, which would otherwise endanger space-based command-

and-control systems—and risk triggering war—in the future.

- Limits on the nuclear forces of France, Great Britain, and China, which are not now subject to arms control.

- Stronger controls on the spread of nuclear weapons and ballistic missiles to countries like India, Pakistan, Israel, and South Africa.

As post-START negotiations proceed, today’s deterrence doctrine and NATO strategy will at some point have to be revised. But the Gorbachev challenge and changing public attitudes are likely to make such a reckoning inevitable regardless of START. Failure to complete the treaty could well increase pressures for the “denuclearization” that START critics fear.

In sum, START represents neither nuclear business-as-usual nor a headlong rush into disarmament. It is an important step in improving U.S.-Soviet relations and winding down a Cold War confrontation that is obsolete and unaffordable. It could yield major security benefits from Gorbachev’s push for political and economic reform and his reordering of Soviet priorities. But the combination of circumstances that has brought a treaty within reach may not last indefinitely. Failure to complete the agreement now could forfeit a unique opportunity. ■

License to Skill

ONE cold winter's day a number of years ago, high in the superstructure of a building under construction, I joined a group peering at the dial of a deflection gauge. The city's building department had ordered a load test to measure how much weight a damaged concrete slab could carry, and several engineers—representing the department, the structural designer, the testing lab, and the contractors—were gathered to record the results.

A quick glance at the dial showed that the deflection of the slab was well within the allowable limits. But the building department's chief inspector would not be hurried into concluding the matter. On a long, legalistic-looking document, he began to fill in the date, time, location, temperature, and names of all those present. He then asked for the registration number on everyone's state professional engineer's license. After fumbling about in our wallets, we produced the requested information, which he recorded with great solemnity. Clearly, he viewed the professional license as a meaningful credential and its holders as members of a select company. I found the occasion curiously moving.

Some months later, while visiting an IBM facility in North Carolina, I was surprised to hear several engineer-executives disparage the concept of state licensing. They conceded that licensing might serve a useful purpose for independent consulting engineers who have to file plans with municipal building departments. But for the vast majority of engineers who work in large corporations, the executives argued, licensing is unnecessary, undemocratic, and pretentious.

I should have known better than to expect any different reaction. Most American engineers *do* work for large corporations and will never need to file plans with a government agency or "place their seal" on their work. They do not need a license to earn an accredited degree from an engineering school, get a job as an engineer, or move successfully along a career path. As might be expected, they show profound disinterest in



*Engineers
should take the idea of
professional licensing
more seriously.*

in the mattering. According to a recent survey, less than half of all U.S. engineering students take the first part of the professional engineer's exam prior to or immediately after graduation. Only 13 percent of engineering schools require their students to take the exam, and only 3 percent require them to pass.

Regardless of what esteemed engineers in large corporations may think, I consider this situation deplorable. Becoming a professional engineer in today's world should certainly include obtaining a government-sanctioned license, as long as the licensing process itself is controlled by the profession, as it now is.

Membership in voluntary professional societies is no substitute for licensing. The Justice Department has recently limited the power of these societies to discipline their members, on the grounds

that, according to anti-trust legislation, society rules and regulations constitute a "restraint of trade." And the sad fact is that less than half of American engineers are members of professional societies anyway.

Lately, we have heard a lot of well-intentioned platitudes about engineering ethics. What could better show our seriousness than to insist that all engineers (or at least all future ones) obtain licenses? Possessing a license—something that is hard-earned yet can be taken away—can do wonders for the conscience. I have heard many a consulting engineer say, "Why, I wouldn't think of doing that; it could cost me my license."

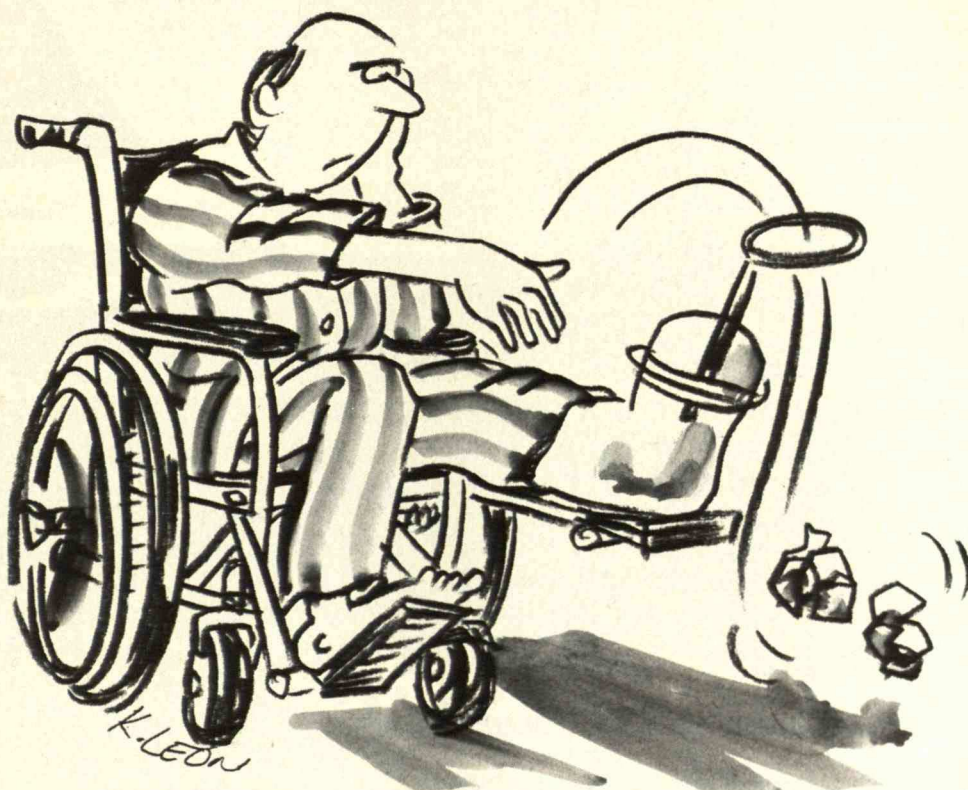
Such an attitude might prove useful in industry. In large, bureaucratic organizations, engineer-employees tend to feel isolated, cut off from their professional roots. Having a state license could remind them—and those who work with them—of their identity as engineers. This would both add force to their voice in the workplace and strengthen their sense of personal, professional responsibility.

Beyond issues of ethics and discipline, however, there lies the question of pride in profession. Without a serious respect for licensing, engineering sets itself apart from its fellow professions—not only medicine and law but also nursing, teaching, and others. By what we do—or fail to do—we often make statements about our moral priorities.

Clearly, no test can establish competence nearly as well as a degree from an accredited engineering school. And admittedly, a fondness for credentials and ceremony can lead to shallow bombast. Still, engineering is more than just a job. In many respects, it is a calling. If engineers are committed to serving the community, then their acceptance of state licensing helps make this commitment manifest. ■

SAMUEL C. FLORMAN, a civil engineer, is the author of Engineering and the Liberal Arts, The Existential Pleasures of Engineering, Blaming Technology, and The Civilized Engineer.

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The Wrong Signals

THERE has been a lot of recent talk about the importance of education to the future of the U.S. economy. Competing in a high-tech world requires well-educated and highly committed workers, the argument goes, and creating such a workforce by improving our educational system should be a top priority. This is especially true for minority Americans. According to the U.S. Department of Labor, one out of every three new entrants to the labor force by the year 2000 will be non-white.

But in all the debate about educating a new generation of workers, few talk about the signals these workers receive when they enter the labor market. It may be a truism of American culture that the path out of poverty is a good education, which in turn will lead to a good job. But when black children look at their elders, they see disproportionately low wages—even for the best educated.

Together with my colleague Lucy Gorham, I recently compared the wage levels of black and white workers between 1979 and 1987. Our work is based on data from the monthly household interviews conducted by the U.S. Census Bureau, generally considered among the best government surveys in the world. The numbers are deeply disturbing.

The 1980s have not been good for wage earners in general, but they have been especially bad for blacks. For example, between 1979 and 1987, the number of "full-time-equivalent" white workers with wages below the poverty line for a family of four—about \$12,000 in 1987 dollars—grew by nearly 31 percent. For blacks, the increase was 44 percent. By 1987, a black worker was three times as likely to earn an income below the poverty line as a white worker. This reverses the trend from 1963 to 1979, when the proportion of low-wage jobs was falling for all racial and demographic groups, and the gap between average black and white wages was narrowing.

Even more alarming are the figures for black men in their late twenties and early thirties—a time when most people are settling into their careers. In the past de-



Minority workers are crucial to the future of the U.S. economy, but the labor market is sending them the opposite message.

cade, the number of black men aged 25 to 34 who have found jobs but who still earn a poverty wage increased by 161 percent. And this statistic understates the problem, because it does not count those who haven't found work or who, discouraged by their inability to find a decent job, have dropped out of the active labor force altogether.

But perhaps the most disturbing finding of our study is that higher education doesn't necessarily solve the problem. In 1987, the wages of one out of six white male college graduates were below the poverty line. For blacks, it was one out of three. Among female college grads, three out of eight whites earned poverty-level wages in 1987, versus nearly half the blacks.

The gap between white and black earnings also holds at the upper end of the income scale. Of course, there are many successful black professionals. But

the sobering fact is that in 1987, 300,000 fewer college-educated black men earned \$36,000 or more than earned the equivalent in 1979. The number of black women with the same amount of schooling who earned this much did grow during this period, but only by 15,000. That's a meager 7 percent increase over nearly a decade.

This situation is not only a national disgrace. It is an unaffordable economic waste. The U.S. economy is about to face a serious labor shortage at practically all occupational levels. And corporate managers are saying they desperately need technologically literate employees. In such circumstances, we need to convince a new generation of workers that staying in school will pay off in the labor market.

Some businesses and local governments have begun to grasp the seriousness of this problem. Companies have joined with local school boards to advise on curriculum. Other firms are promising entry-level jobs to kids from poor neighborhoods who stay in school, show a respectable attendance record, and graduate from high school with a "B" average. And city councils and state governments are trying to fill the budgetary chasm created by the federal government's disinvestment in education over the past decade.

But local initiatives cannot substitute for national policies aimed directly at improving work opportunities for minorities: raising the minimum wage, enforcing laws and regulations governing affirmative action and equal employment opportunity, and promoting the kind of economic development that creates new jobs at decent wages. As we plan the radical overhaul of our school systems in the years ahead, we need to pay more attention to the wage incentives provided by employers. ■

BENNETT HARRISON, a professor in MIT's Department of Urban Studies and Planning, is currently a visiting professor at Carnegie-Mellon University in Pittsburgh. His most recent book, co-authored with Barry Bluestone, is *The Great U-Turn*, published by Basic Books.

Reviews

BOOKS

CHARTING THE PLANETS

*Journey into Space:
The First Thirty Years of Space Exploration*
by Bruce Murray
W.W. Norton & Co., \$19.95

BY WALTER A. MCDUGALL

THE press coverage of *Voyager 2*'s encounter with Neptune last August was the most celebratory to accompany any unmanned spacecraft since the *Viking* landers looked for life on Mars in 1976. Perhaps it was simply because this was *Voyager*'s swan song. Or perhaps the *Challenger* explosion overshadowed the craft's visit to Uranus in January 1986. But perhaps, too, editors are beginning to learn who—and what—has done the real space exploration over the past 30 years: not the shuttle, not the brave astronauts and moribund bureaucrats at NASA headquarters, and not the big metal-benders of the aerospace industry. Exploring the planets and stars has always been conducted, in anonymity and on a shoestring, by the engineers and scientists of the unmanned programs at NASA's "lesser" centers. Premier among these is the Jet Propulsion Laboratory (JPL) in Pasadena, Calif., whose former director Bruce Murray is the author of this book.

The reader who picks up *Journey into Space* expecting a comprehensive history of the world's space programs will be disappointed. This is not a history but a memoir. Nevertheless, when humans dream of space travel, it is the planets that grip their imagination, and that is what Murray's career is all about. His account is a tale of extraordinary scientific ingenuity and accomplishment. It is also a story about the clash of science and politics that has shaped the U.S. space program.

In October 1960, when Murray was a geologist and Air Force officer, he



peered through a telescope and fell in love with Mars—so strangely akin to Earth with its polar ice caps, seasons, and 24-hour rotation. Back in the early days when NASA was committed to a "well-rounded" space program, writes Murray, scientists at JPL were captivated by "the ghost of Percival Lowell," the turn-of-the-century astronomer who popularized the fantasy of Martian canals, foliage, and possibly intelligent life. In 1965, the JPL team coaxed *Mariner 4* to transmit the first close-up pictures from the Red Planet. Each frame consisted of 40,000 picture elements or "pixels," and the primitive telemetry of the time was able to transmit only one pixel per second. JPL scientists waited "with excruciating anticipation"—only to discover that the images had been rendered unintelligible by Martian dust and solar glare.

Undiscouraged, JPL scientists worked around the clock and invented a rudimentary version of computerized image-processing, which made it possible to unscramble the pictures. To everyone's surprise, Mars looked not like Lowell's living planet, not even like a terrestrial desert, but like the moon. And when *Mariner 4* sailed around the edge of Mars, placing the planet's atmosphere between the spacecraft and Earth, its radio signals showed very lit-

tle dispersion. This proved that Martian atmospheric pressure was only one-half of 1 percent that of Earth's (so thin that liquid water would instantly vaporize). Our image of Mars went to the other extreme: the planet was dry, cratered, and dead.

The 6,786 pictures from the 1971 *Mariner 9* mission changed our view of Mars once again. They revealed sedimentary deposits near the poles, a sign that at some point in the past, liquid runoff had occurred. This demonstrated that Mars had seasons, but that their intensity fluctuated over billions of years because the gravitational pull of giant Jupiter and Saturn made the planet's axis wobble. Thus, Mars was recognized as a planet with a complicated history that included periods of moderate climate, possibly surface water, and maybe even life. We were "peeling Mars like an onion," Murray writes.

In April 1976, Murray became director of JPL, just in time to preside over the *pièce de résistance* of Martian exploration, the adventure of the *Viking* landers with their remote-control chemical laboratories designed to scoop up Martian soil and analyze it for organic compounds. Interestingly, Murray believed from the start that the results of these experiments would be ambiguous. It was highly unlikely that the landers would discover clear signs of life, but such a failure wouldn't prove that rudimentary plants or bacteria did not exist elsewhere on the planet. Nor would it prove that life had not existed in the past. Murray's pessimism proved well-founded; *Viking* found nothing. But he believes the question of whether life exists on Mars remains open.

Grand Tours and Turf Battles

Journey into Space is not just about scientific achievements. The backdrop to Murray's story is the continuous political conflict between NASA administrators and JPL scientists, and the steady decline of support at NASA for space science, culminating in the agency's preoccupation with the ill-conceived shuttle.

This is most clearly seen in the story of the *Voyager* spacecraft. The *Mariner 10* mission to Mercury had demonstrated the efficacy of the "slingshot effect," which used the gravity of Venus to accelerate the spacecraft on course to Mercury despite the overwhelming gravitational pull of the nearby sun. JPL conceived of using the same propulsion technique to send a spacecraft on a grand tour of the distant outer planets. Theoretically, a craft boosted by rocket power to Jupiter could use that planet's mighty gravity to slingshot to Saturn and just possibly beyond.

But NASA's political and budgetary constraints and obsession with flashy manned missions almost doomed the *Voyager* flights before they got off the ground. At one point, Murray was tersely informed that the "grand tour" project had been killed. Only after repeated lobbying in Congress and the White House was the project reinstated. And even then, the budget and launch vehicle JPL had to work with were insufficient to guarantee that *Voyager* would be able to travel beyond Saturn. To its lasting glory, the JPL team carefully planned the launch date and trajectory of *Voyager 2* so that the spacecraft might have just enough oomph to push on to Uranus and Neptune.

Murray is especially good at telling how JPL scientists and computer folk worked and worried during the months and years when one of their "birds" was between the outer planets. For instance, the *Voyager 2* team had to act "like futuristic brain surgeons" to reprogram or reactivate the spacecraft's systems as it made its way to Jupiter. They were rewarded in 1979, when they received images of Jupiter's moons so striking that it seemed to Murray as if the craft were "wandering through a cosmic Louvre."

By the time *Voyager* reached Saturn in August 1981, JPL scientists had been at work for nine months figuring out how to nudge it out a billion more miles to Uranus, and how to goose its already ancient 32K RAM computers to "compress" photographs for transmission from such a distance. The ingenious solution this time was to instruct the com-



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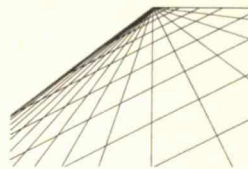
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puter to transmit only the mathematical differences in light intensity between adjacent pixels, rather than the absolute value of each pixel. This cut the data the computer had to process by a factor of two and a half.

But although Murray writes compellingly about such technical struggles and triumphs, he falters when it comes to describing the turf battles among NASA, JPL, and Caltech. What's missing is the historical context that shaped the lab's conflicts with the NASA bureaucracy. JPL was founded before World War II as the Guggenheim Aeronautical Laboratory of the California Institute of Technology. After the war, its main patron was the Army, which put the lab to work on problems of jet and rocket technology. The Army was content to leave administration in Caltech's hands and made no pretense of challenging the lab's scientific judgments. But in 1959, government patronage of JPL shifted to the newly formed NASA, which treated JPL as a subordinate branch of the agency rather than an independent resource. Caltech scientists, accustomed to operating in a relaxed and creative academic environment, resented the commands and regulations of the Washington bureaucracy, not least when their own scientific judgments were overruled by NASA because of politics, budgets, or public relations.

In the latter portions of Murray's account, his elation and pride give way to bitterness. By the mid-1970s, the morale, numbers, and quality of NASA personnel had plummeted, the shuttle ate up what money there was, and space science went begging. The best efforts of Murray and his colleagues to publicize the scientific space program failed to shift NASA's priorities.

On the other hand, when President-elect Jimmy Carter asked the author himself to become NASA administrator, Murray turned him down. He claims that Carter perceived the space program as unfashionable, elitist, and irrelevant to mainstream social issues. Perhaps we can forgive Murray for ducking what would have been a frustrating and thankless job. Yet I can't help but think

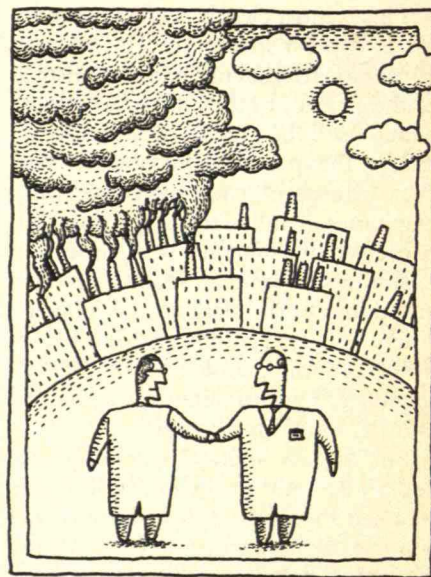
that he would have been able to do more for the NASA science program by accepting the post.

More perplexing still, Murray wraps up his book *not* with a plea to revive the robotic exploration of the solar system, which would make sense both scientifically and financially. Rather, he proposes to expand the costly manned exploration of space, and for unsound political reasons. Murray wants Americans to go to Mars with the Soviets to end the destructive competition between what he calls "the two cultures."

This idea of superpower cooperation in space is a shibboleth to which scientists, whether out of sentiment or guilt, seem especially prone. Murray does not understand that cooperative missions like the *Apollo-Soyuz* rendezvous of 1975 are the result of detente, not the cause. Joint missions multiply the costs and risks of space travel because it is so difficult to integrate different nations' technologies. And the prospects that such flights could hold public and official support for two decades in both Washington and Moscow are slim. In any case, robotic missions glean many times the scientific return per dollar.

Given Murray's confessed love affair with Mars, I wonder if his real motive for pushing a joint U.S.-Soviet mission to the Red Planet is more personal than professional. He quotes Ray Bradbury's moving poem "If Only We Had Taller Been" and calls spaceflight "a half-conscious search for immortality." To be sure, there is much about our encounter with outer space that leads us to ponder the meaning of human existence, and space enthusiasts are justified in trying to awaken that sense of wonder in the public. But they must also beware slipping into the role of space-age Captain Ahab, pursuing Mars like Moby Dick, and demanding in charismatic tones that we, the crew, follow them whatever the cost. ■

WALTER A. McDUGALL is the Alloy-Ansin Professor of International Relations at the University of Pennsylvania and the Pulitzer Prize-winning author of *...the Heavens and the Earth: A Political History of the Space Age* (Basic Books, 1985).



BOOKS

COOPERATIVE CLEAN UPS

Environmental Cooperation Between the North Sea States
by Sunneva Saetevik
Belhaven Press, \$35.00

International Cooperation Building Regimes for Natural Resources and the Environment
by Oran R. Young
Cornell University Press, \$32.50/\$10.95

BY PETER M. HAAS

CONCERNS about global warming have brought environmental problems to the top of the international political agenda. And yet, for all the attention such problems have received, independent nations have yet to find a satisfactory way of jointly addressing them. Both Sunneva Saetevik and Oran Young are concerned with the obstacles to effective international environmental cooperation, but they come to opposite conclusions about the possibility for improving such collaboration in the future.

Saetevik's book *Environmental Cooperation Between the North Sea States* analyzes the 1974 Paris Convention for the Prevention of Marine Pollution from Land-based Sources, signed by the states bordering the heavily polluted North Sea. The treaty calls for banning the emission of five dangerous substances into that sea and for strict controls on eight other, less toxic substances. The convention also set up a commission to implement the accord and to monitor compliance by the participating countries.

According to Saetevik, the Paris Convention has largely been a failure. Although in principle the participating countries agreed to protect the North Sea from pollution, in practice they have rarely agreed on binding regulations for specific pollutants.

Saetevik attributes this failure to conflicts inherent in international relations. Each sovereign nation pursues its own narrow economic and political interests, and power politics determines the outcome. Since all countries both produce and suffer from pollution, says Saetevik, net importers of pollution will favor and promote international control for the sources from which they suffer. Net exporters will argue for more lenient arrangements or even try to avoid controls altogether.

This fact of international life is a major barrier to cooperation on environmental problems. In effect, joint action is limited to the lowest common denominator—only those regulations that the most powerful reluctant participant can tolerate. Thus, efforts to control pollution in the North Sea have often been stymied by the major net exporters of pollution in the region—West Germany and the United Kingdom. Only six binding standards have been adopted from 1978 to 1987, and strong disagreements persist over the precise form standards should take.

Saetevik's emphasis on power politics has a grim plausibility. It helps explain, for example, why powerful industrial nations have dragged their feet on the problem of acid rain. But when it comes to protecting the North Sea, in-

ternational cooperation may be more effective than Saetevik thinks.

The Paris Convention is only one of a number of international forums for cleaning up North Sea pollution. Every five years, the environmental ministers from bordering states hold a major policy meeting that is independent of the Paris agreement. Also, the 1972 Oslo Convention—a precursor to the Paris accord—has eliminated marine dumping in the North Sea. Its ban on ocean incineration will take effect in 1994. Even the Paris Convention itself has done more than Saetevik lets on. In 1985, the signatories extended the agreement to include airborne as well as land-based pollutants. Although it is difficult to measure the impact of these efforts, the North Sea states are regulating many more emissions today than they did in the past. Had Saetevik broadened the scope of her case study, her conclusions might not be so pessimistic.

The real problem with Saetevik's book is that her conception of state interests is too static. She tends to see nations as perfectly rational thinking machines. And she presumes that government decision makers have nearly perfect information, which allows them to calculate their nation's economic interests unambiguously.

But governmental decision making almost never happens that way. What's more, Saetevik's model does not recognize that public opinion and other factors can force government officials to change their minds. Thus, in the early 1980s, West Germany reversed its opposition to European controls on acid rain, even though it is a net exporter of sulphur dioxide and nitrogen oxides. A key factor in this change was not economic but cultural: growing public concern in West Germany over the environmental deterioration of the Bavarian forests. Today, West Germany has the strictest acid rain standards in Europe.

Like Saetevik, Oran Young is especially interested in why cooperation among nations breaks down. But he is more confident that countries can create new institutional arrangements to encourage it. In *International Cooper-*

ation Building Regimes for Natural Resources and the Environment, he examines four cases of international environmental cooperation—marine fisheries, deep seabed mining, responses to nuclear accidents, and Arctic shipping—and develops some persuasive propositions for promoting joint action.

Unlike Saetevik, who focuses on power politics, Young emphasizes the dynamics of negotiation and bargaining among many sovereign states. Countries often recognize the value of cooperation, he argues. But because there is no one source of authority in the international sphere, competing nations often don't trust each other. As a result, the temptation to opt out of joint agreements—in effect, to leave other nations with the costs of environmental protection—is simply too great. And because no nation wants to bear more than its share of these costs, nations are rarely willing to commit themselves to strong cooperative arrangements from the start.

Young proposes a number of mechanisms to enhance the prospects for cooperation. Instead of focusing on a single issue or problem, international negotiations should combine several, to make compromises easier. For instance, discussions about the Arctic would combine negotiations on regional science, security, navigation, and fisheries. That way, disagreement on any one issue can be resolved through trade-offs on others.

Negotiations should also emphasize the uncertainties surrounding an issue. When governments are unsure about who suffers most from a problem or what the costs of resolving it will be, they are less likely to scuttle cooperation. A sense of crisis can overcome stalemate and strengthen collective initiatives by forcing countries to act even in the face of uncertainty.

Finally, Young argues that governments should be encouraged to include decision makers from many different agencies in the negotiation, on the theory that the more constituencies involved, the harder it will be for that

government to withdraw.

Many of these proposals are provocative and useful. But Young focuses too much on overcoming obstacles to cooperation among countries that already sense it is in their best interest to work together. Thus, he never considers how countries go about defining their interests in the first place. His approach may improve the chances for international cooperation, but Young has little to say about what the substance of such cooperation might be.

What both these books miss is the increasingly central role of environmental scientists. Most international environmental issues involve enormous uncertainty—about the extent of pollution, the interaction of pollutants, the long-term effects, the costs of cleanup, and the like. Government leaders and international bodies like the U.N. often rely on technical experts to address this uncertainty. And this gives extraordi-

nary influence to informal international networks of scientists.

If the experts can agree among themselves on the likely causes of a problem and effective policies for addressing it, they can be a powerful catalyst for consensus. As policymakers incorporate expert advice into their decisions, individual governments often redefine their interests in ways that offset the traditional obstacles to cooperation.

One example is the Mediterranean Action Plan, developed between 1975 and 1980 to protect the Mediterranean Sea. The United Nations Environment Programme (UNEP) and the regional governments developed the plan, spurred by scientists throughout the region. Marine scientists heightened public concern, identified pollutants for collective regulation, suggested specific environmental standards, and pressed states to comply with international treaties. Their influence caused some

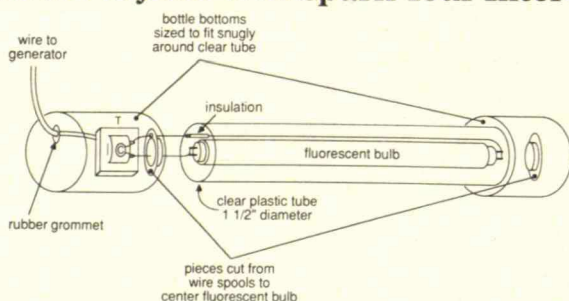
governments—notably Algeria—to reverse their longstanding opposition to regional controls. The Mediterranean is now in far better condition than anyone would have imagined 15 years ago.

In a sense, the reason Saetevik and Young both emphasize the many obstacles to international environmental cooperation is that they have been looking in the wrong place. While they focus on the actions—or inaction—of government leaders, international networks of scientists have been forging a new global consensus on the environment. They represent an important new alternative to formal state efforts in environmental protection. ■

PETER M. HAAS is an assistant professor of political science at the University of Massachusetts at Amherst. His book *Saving the Mediterranean: The Politics of International Environmental Cooperation* will be published by Columbia University Press in April 1990.

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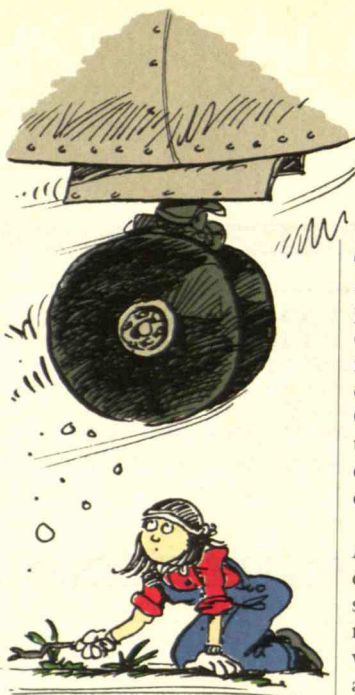
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Notes



Deweeding Chicago

The world's busiest airport will test a product that could free streets, highways, parking lots, and runways of weeds for up to two decades.

Batelle researchers will help a Chicago construction contractor apply GrowGuard to the cracks and seams of the taxiway and runways at O'Hare Airport. The 18-month project will indicate how long the product remains effective.

GrowGuard merges synthetic polymers and Trefland, a herbicide that slows root growth. The polymers, which act as a reservoir for the herbicide, slowly release it.

Shot from Guns!

"Explosion puffing," long reserved for cereals, can also preserve fruits and vegetables. According to the *Journal of Food Science*, the procedure first partially dries foods—peppers, mushrooms, strawberries—with hot air. Next, a change in air pressure "explodes" the foods, which are then dried further.

Puffed foods absorb water better, enhancing taste and other properties. And explosion puffing is cheaper than freeze-drying or other advanced drying methods.

Soviet Glow

Rampant radiation leaks have prompted Soviet officials to order the production of home radiation testers, which will go on sale this year. Sovietologist Gabriel Schoenfeld observes that one Soviet expert recently called his nation "an ecological disaster zone."

Writing in the *Bulletin of the Atomic Scientists*, Schoenfeld describes a "major health crisis stemming from unsafe uranium mining, processing, and waste disposal, and from radiation leaks associated with Soviet nuclear weapons manufacturing, storage, and testing." Last spring, a Soviet Ministry of Internal Affairs lecturer told of "unmarked burial sites containing radioactive waste from production, science, and medicine—various ampules, flasks, gowns, and a host of other 'contaminated' items—near virtually every major industrial center."

Senior Computers

Seniors may gain a window on the world with Eldernet, a computer network being created by Drexel University professor of information studies Margaret Christensen. By connecting an elder's home with a hospital, the network could aid medical monitoring. A nurse could enter a medication schedule into a hospital terminal, and the home computer would tell the elder when to take the next dose. If no one responded, the computer would send out an emergency signal.

Eldernet could also run errands to grocery stores, libraries, and pharmacies. A person could scan lists of goods and order necessities without leaving home. And to help people with physical handicaps, Eldernet would have voice synthesizers and touch-sensitive screens.

Pollution Spread

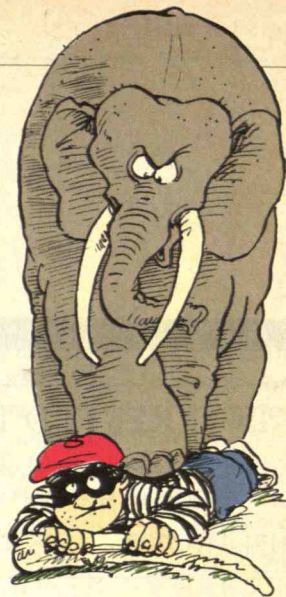
In 1988, dangerous levels of air pollution threatened 30 million more U.S. city dwellers than the year before, reports *Engineering Times*. Citing EPA data, the *Times* notes that two-fifths of Americans inhabited cities with unhealthy ozone-related smog.

Of the 101 areas on EPA's dirty list, 37 were new for 1988. "This sharp increase . . . is dramatic proof of the pressing need for a new clean-air bill," says EPA head William Reilly.

Music Science

Oberlin College's Conservatory of Music is building the first high-tech laboratory for singers. To visualize a singer's resonance frequencies, the lab will have both a sonograph coupled to a printer and a spectrum analyzer with video monitors. An electrolaryngograph will provide data on vocal cords, producing pictures of breathy singing. Other equipment will display vibrato, oscillation, and tremolo.

Notes lab director Richard Miller, "The same kinds of applications of scientific information that have been going on in sports in the area of biomechanics need to be applied to vocal pedagogy."



DNA Saves Elephants

Washington University biologist John Patton is applying DNA fingerprinting to the fight to protect elephants. In Kenya, perhaps the worst-hit nation, ivory poachers have reduced elephant herds from 130,000 in 1973 to 17,000 today.

Patton is building a genetic database of tusks confiscated by African authorities and hopes to pinpoint the type of elephant each tusk comes from, as well as the part of Africa where that type lives. That could prove when suspect ivory has been collected illegally. "DNA fingerprinting may help us propagate a species that is suffering need-less slaughter," he says.

Seasonable Fashions

Imagine a jacket that cools you after a sweaty downhill ski. Imagine that 20 minutes later the same jacket protects you from cold winter air. The key to "phase-change" sportswear may be PEG 1000—polyethylene glycol, which has a molecular weight of 1,000. As this waxy substance warms, it hardens, releasing heat. Then when it cools down, it softens, absorbing heat.

Dermatologist Steven Harlan of Des Moines, Iowa, has tested skiwear and underwear containing PEG 1000 on 50 volunteers. He has told an American Chemical Society meeting that all the results—including cooling, warming, skin comfort, and thermal and solar insulation—are positive.

Buick is the only American car to make the top 10...



in 3 major consumer surveys.

These surveys, conducted by J.D. Power and Associates, recently measured consumers' opinions three different ways:

- **Customer satisfaction** with product and dealer service after one year of ownership.
- **Sales satisfaction** with the car, the way it was sold and delivered by the dealer.
- **Initial quality**, based on owner-reported problems during the first 90 days of ownership.

In the Initial Quality Survey, Buick LeSabre ranked as the most trouble-free American car. And Buick Riviera and Electra/Park Avenue ranked as the two most trouble-free American luxury cars.

Out of over 150 models, Buick was the only domestic brand to make the top 10 in all 3 surveys.

Now, the 1990 editions of these premium automobiles are available. If you're looking for quality—go looking for your Buick dealer.



The New Symbol for Quality in America.

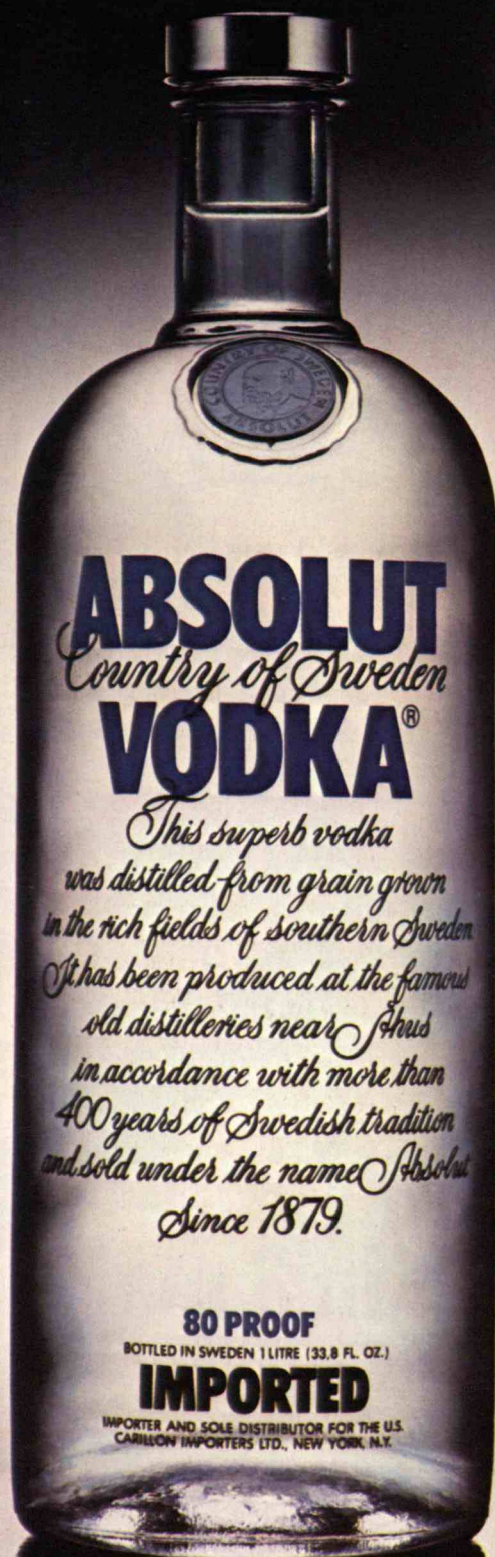
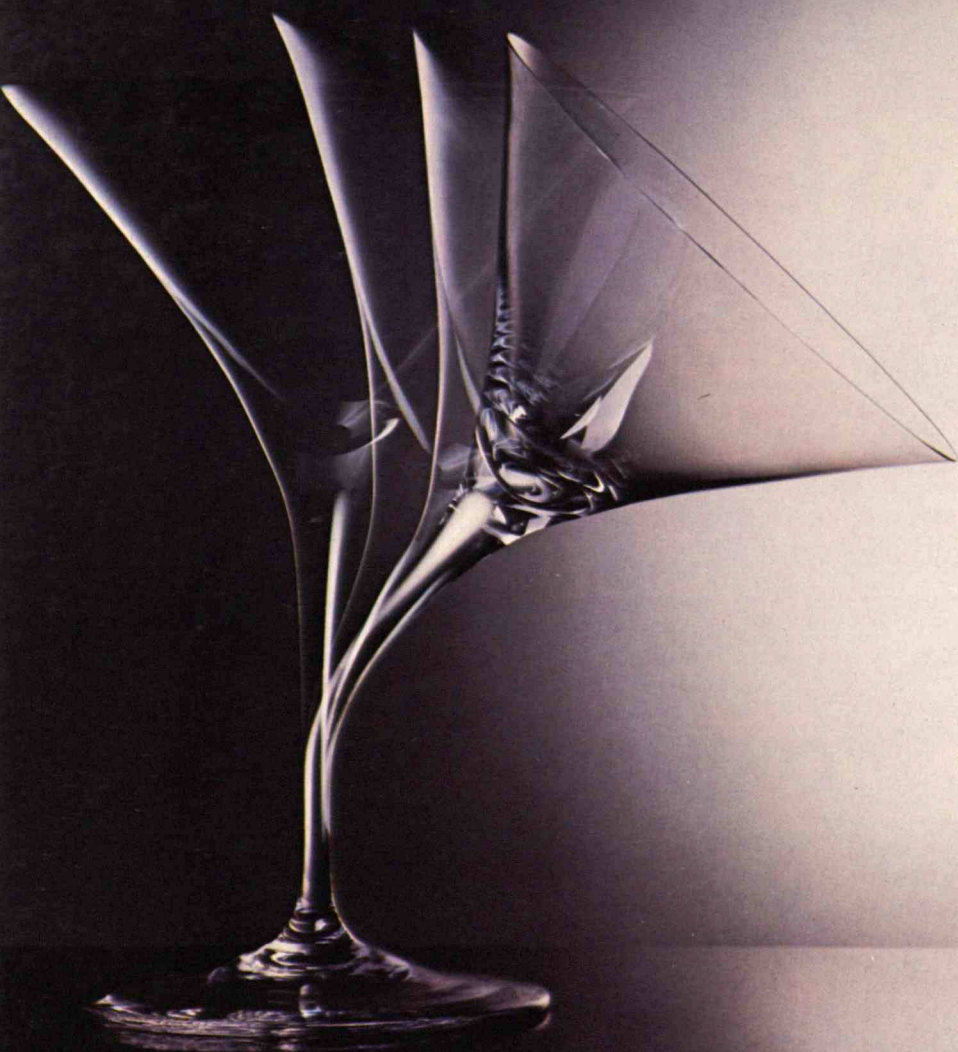
BUICK

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SMARTLEASE
by GMAC



Let's get it together...buckle up.

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J.D. Power and Associates 1989 Customer Satisfaction with Product Quality and Dealer Service™ Buick ranked 10th overall. 1989 New Car Sales Satisfaction Index™ Buick ranked in a tie for 3rd overall. 1989 Initial Quality Survey™ Buick ranked 7th overall.



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